2025 Course Catalogue

POSTECH Graduate Program

POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY
포항공과대학교

Contents

Department of Mathematics

1. Education Aim

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

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

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

2. Program Overview

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

[MS/Ph. D Integrated Program]

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 accordance to the University's regulations on conferring of degrees. Once the student passes the review, he/she will go through several minor administrative processes for Doctor's Degree Conferment.

B. To graduate with MS degree

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

(1) Earn at least 28 credits (including 18 coursework credits)

(2) Submit a master's thesis

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

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

[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, 605, 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, 626)
Stream4 : Numerical Analysis and Applied Mathematics
(541, 542, 551, 640, 641, 643, 645, 647, 651, 652)
Stream5 : Probability, Mathematical Statistics, Financial Mathematics and related subjects
(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.

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

<u>A minimum of 3 colloquium credits are required for graduation. Register for MATH799 (Seminar) during a course registration period.</u>

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

[Research Ethics (ICEC501) Course Guide]

1) Graduate students admitted in the 2023 academic year must complete the course during their studies.

2) This is a graduation requirement (1 credit), but not counted as graduation completion credits.

3) Considering the nature of research in mathematics, graduate students in mathematics must complete the syllabus covered in all weeks but weeks 4, 9, 10, and 11.

Excluded topics are as follows:

Week 4, writing and managing research notes
Week 9, understanding bioethics
Week 10, principles and practices of experimental animal protection
Week 11, the role of institutional bioethics committees

3. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	Does not count as credits for graduation
				Research Paper Presentation Skill	
			Requirement	Research Ethics	
Math	Core Requirements		Major Requirement	-	
	Core Electives (by Major)	Algebra, Number Theory, Algebraic Geometry (Stream1)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Algebra I	
				Algebra Ⅱ	
				Commutative Algebra	
				Commutative Ring Theory	
				Algebraic Number Theory	
				Analytic Number Theory	
				Additive Number Theory	
				Introduction to algebraic geometry	
				Finite Group Theory	
				Algebraic Geometry	
				Elliptic Curves	
				Algebraic Groups	
				Automorphic forms	
				Homological Algebra	
				Topics in Algebra	
				Topics in Number Theory Algebra	
				:	
		Real Analysis, Complex Analysis, Partial Differential Equations (Stream2)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Complex Analysis)	
				Real Analysis I	
				Real Analysis Ⅱ	
				Partial Differential Equations	
				Ergodic Theory	
				Functional Analysis	
				Calculus of Variations	
				Several Complex Variables	
				Fourier Analysis	
				Harmonic Analysis	
				Theory of Banach spaces	
				Nonlinear Partial Differential Equations	
				Topics in Analysis	
		Topology, Geometry (Stream3)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Differentiable Manifolds	
				Introduction to Differential Topology	
				Algebraic Topology I	
				Discreate and Computational	

Classification			Category	Course Title	Remarks
				Geometry	
				Riemannian Geometry	
				Complex Manifolds	
				Differential Topology	
				Algebraic Topology II	
				Lie Groups and their Representations	
				Symplectic Topology	
				Topics in Geometry	
				Topics in Topology	
		Numerical Analysis and Applied Mathematics (Stream4)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Methods of Applied Mathematics I	
				Methods of Applied Mathematics II	
				Numerical Analysis	
				Eigenvalue and Boundary Value Problems	
				Mathematical Fluid Dynamics	
				Nonlinear Partial Differential Equations	
				Advanced Numerical Analysis	
				Numerical Analysis of PDE	
				Topics in Applied Mathematics	
				Topics in Numerical Analysis	
		Probability, Mathematical Statistics, Financial Mathematics (Stream5)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Mathematical Statistics	
				Probability Theory	
				Applications of Mathematics and Big Data	
				Regression Analysis	
				Stochastic Calculus & Financial Mathematics	
				Enviromential Statistics	
				Topics in Statistics	
				Topics in Computational Mathematics	
		Cryptology, Coding Theory, Combinations (Stream6)	Major Requirement	-	Complete at least one course from 3 streams out of the 6 streams
			Major Elective	Applied Geometry for Computer Graphics and Vision	
				Combinatorics I	
				Combinatorics II	
				Coding Theory	
				Algebraic Cryptology	
				Algebric Graph Theory	
				Topological Graph Theory	
				Topics in Combinatiorics	

Classification			Category	Course Title	Remarks
				Topics in Coding Theory	
				Topics in Cryptography	
	Common Course		Requirement (Research subjects)	Seminar	Ph.D students are required to obtain at least three credits
			Research subjects	Master Thesis Research	Master's Program
			Research subjects	Doctoral Dissertation Research	Ph.D Program, MS/Ph.D Integrated Program
	Interdisciplinary Electives		Major Elective	Undergraduate MATH400-level courses	Letter graded, up to 6 credits
				Graduate courses offered by other programs	Letter graded, up to 6 credits, Research/seminar courses are not counted

4. Departmental Curriculum Roadmap

Major	Category		Course Title
Math	Univ. Common Course		Scientific Writing for Graduate Students, Research Paper Presentation Skill Research Ethics (Requirement)
	Dept. Core Required Electives		-
	Major Electives by major (Complete at least one course from 3 streams out of the 6 streams)	Algebra, Number Theory, Algebraic Geometry (Stream1)	AlgebraⅠ, Algebra Ⅱ, Commutative Algebra, Commutative Ring Theory, Algebraic Number Theory, Analytic Number Theory, Additive Number Theory, Introduction to algebraic geometry, Finite Group Theory, Algebraic Geometry, Elliptic Curves, Algebraic Groups, Automorphic forms, Homological Algebra, Topics in Algebra, Topics in Number Theory Algebra
		Real Analysis, Complex Analysis, Partial Differential Equations (Stream2)	Complex Analysis), Real AnalysisⅠ, Real AnalysisⅡ, Partial Differential Equations, Ergodic Theory, Functional Analysis, Calculus of Variations, Fourier Analysis, Harmonic Analysis, Theory of Banach spaces, Nonlinear Partial Differential Equations, Topics in Analysis
		Topology, Geometry (Stream3)	Differentiable Manifolds, Introduction to Differential Topology, Algebraic Topology I, Discreate and Computational Geometry, Riemannian Geometry, Complex Manifolds, Differential Topology, Algebraic Topology II, Lie Groups and their Representations, Symplectic Topology, Topics in Geometry, Topics in Topology
		Numerical Analysis and Applied Mathematics	Methods of Applied MathematicsⅠ, Methods of Applied MathematicsⅡ, Numerical Analysis, Eigenvalue and Boundary Value Problems,

Major	Category		Course Title
		(Stream4)	Mathematical Fluid Dynamics, Nonlinear Partial Differential Equations, Advanced Numerical Analysis, Numerical Analysis of PDE, Topics in Applied Mathematics, Topics in Numerical Analysis
		Probability, Mathematical Statistics, Financial Mathematics (Stream5)	Mathematical Statistics, Probability Theory, Applications of Mathematics and Big Data, Regression Analysis, Stochastic Calculus & Financial Mathematics, Enviromential Statistics, Topics in Statistics, Topics in Computational Mathematics
		Cryptology, Coding Theory, Combinations (Stream6)	Applied Geometry for Computer Graphics and Vision, Combinatorics Ⅰ, CombinatoricsⅡ, Coding Theory, Algebraic Cryptology, Algebric Graph Theory, Topological Graph Theory, Topics in Combinatiorics, Topics in Coding Theory, Topics in Cryptography
	Common Course		- Seminar (Ph.D students are required to obtain at least three credits) - Master Thesis Research - Doctoral Dissertation Research
	Interdisciplinary Electives		- Undergraduate MATH400-level courses (Letter graded courses, up to 6 credits) - Graduate courses offered by other programs. (Letter graded courses, up to 6 credits, Research/seminar courses are not counted.)

5. 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 thoery, 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, Baysian method

MATH531 Probability Theory ······ (3-0-3)

Recommended Prerequisite : MATH311, 431

Probability measure theory, Stochastic process, Brownian motion, Markov property, Weak convergence, Infinitely decomposable distribution, Martingale, Stochastic integral equation, Stochastic differential equation, Probability approximation

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

Basic Mathematical Theory for Evaluation of Financial Asset, Analysis, Portfolio Model, Stochastic Process and Probability Differential Equations

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, WKB 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 ··· (3-0-3)

Voltage graph, Group actions on graphs, Cayley graph, Embedding of graphs, Map Colorings, Genus of groups, Graph and matrices, Algorithm

MATH562 Combinatorics Ⅱ ··· (3-0-3)

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

MATH565 Coding Theory ·· (3-0-3)

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

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

Recommended Prerequisite : MATH302

Public key crypto-algorithm, Cryptanalysis, Finite field Study public key cryptosytem based on a various number theoretical theories. We will discuss such as elliptic curve crypto system and RSA systems

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

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

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

Recommended Prerequisite : MATH 503, 524, 612

Complex variety, Hilbert's nullstellensatz, Riemann surfaces and algebraic curves, Residues, Quadric Line Complex

MATH604 Elliptic Curves ·· (3-0-3)

Recommended Prerequisite : MATH505

Algebraic varieties, Algebraic curves, Geometry on elliptic curves, Elliptic curves on local fields, Elliptic curves on global fields.

MATH605 Algebraic Groups ·· (3-0-3)

Recommended Prerequisite : MATH501

Algbraic group, linear algebraic group, Classification of diagonalizable groups and tori in terms of character groups, solvable group, unipotent group, Borel group, parabolic group, reductive group, semisimple algebraic group, component group, root system, Dynkin diagram, Classification of reductive groups and semisimple algebraic groups.

MATH606 Automorphic Forms ·· (3-0-3)

Modular Form, Siegel modular form, Jacobi form, Quadratic form, L-function

MATH608 Homological Algebra ·· (3-0-3)

Recommended Prerequisite : MATH301

We study the basic concepts in homological algebra such as Hom, Tensor, Ext, Tor and show how these can be applied to solve purely algebraic problems.

MATH612 Several Complex Variables ········ (3-0-3)

Recommended Prerequisite : MATH510

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

MATH616 Fourier Analysis ········ (3-0-3)

Recommended Prerequisite : MATH311

Basic Properties of Fourier Series, Uniform Convergence, Convergence & Divergence at a point, Hardy-Littlewood Maximal function, Fourier Transform on Lebesgue space

MATH617 Harmonic Analysis ········ (3-0-3)

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 ········ (3-0-3)

Recommended Prerequisite : MATH519

Basic sequences, Classical Banach spaces, Devoretsky-Rogers Theorem, Grodendick inequality, Choquet Integral Representation Theorem

MATH621 Riemannian Geometry ········ (3-0-3)

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 ········ (3-0-3)

Recommended Prerequisite : MATH520

Sheaves, Cohomology, Infinitesimal Deformations, Geometry on Hermitian & Kaehler manifold

MATH623 Differential Topology ········ (3-0-3)

Recommended Prerequisite : MATH520

Manifold Embedding, Sard Theorem, Transversality, Vector Bundle Theory, Euler number, Hopf Degree, Morse Theory, Cobordism Theory

MATH624 Algebraic Topology II ········ (3-0-3)

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

MATH626 Symplectic Topology ········· **(3-0-3)**

Recommended Prerequisite : MATH520

The least action principle, Hamiltonian mechanics, symplectic manifold, Hamilton's equation, Lagrangian submanifold, Gromov-Witten-Floer theory

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 Dunamics, 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

MATH769 Topics in Cryptography

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 Doctoral and MS/PhD Integrated Program. 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 and at least 4 of which must be research 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)

[Doctoral Program]

A. The minimum number of credits required for a Ph.D. degree is 32, at least 12 of which must be coursework credits and at least 20 of which must be research credits. Credits earned during a master's program are excluded.

B. Required Courses

- Doctoral Dissertation Research (variable credits; may be taken more than once)
- Coursework

Category	Course No.	Course Title (Credit)
Major Required	PHYS501	Analytical Mechanics (3) (replaceable with PHYS502 Advanced Mechanics)
	PHYS512	Statistical Mechnics (3) (replaceable with PHYS513 Advanced Statistical Mechanics)
	PHYS503	Electrodynamics I (3)
	PHYS505	Quantum Mechanics I (3)
	PHYS801	Colloquium (1) (required two-time completion, S/U)
Major Elective Required **(6 credits required)** * The Graduate Studies Committee shall determine whether or not to accept the completion. ▪ Only the credits took after entering the Graduate Course are accepted.	PHYS504 PHYS506 PHYS820 The corresponding Course No.	Electrodynamics II (3) Quantum Mechanics II (3) Lab Rotation (3) (S/U) 200-level or higher of undergraduate courses (another department)-related fields*
	(Condensed Matter Physics)	
	PHYS401 PHYS521 PHYS522 PHYS610 PHYS663 The corresponding Course No.	Solid State Physics (3) Solid State Physics I (3) Solid State Physics II (3) Many Body Theory (3) Phase Transition and Critical Phenomena (3) Condensed Matter Physics-related special topics*
	(Particle Physics)	
	PHYS403 PHYS601 PHYS606 PHYS611 PHYS613 The corresponding Course No.	Nuclear and Elementary Particle Physics (3) Quantum Mechanics III (3) Elementary Particle Physics (3) Quantum Field Theory (3) Theory of Relativity (3) Particle Physics-related special topics*
	(Optics/Atomic Physics)	
	PHYS410 PHYS690 PHYS692 The corresponding Course No.	Optical Physics (3) Advanced Optics (3) Quantum Optics (3) Optics/Atomic Physics-related special topics*
	(Biophysics)	
	PHYS413 PHYS667/IBIO612 The corresponding Course No.	Biological Physics (3) Quantitative Theoretical Biology (3) Biophysics-related special topics*
	(Plasma/Accelerator Physics)	
	PHYS406 PHYS615 PHYS616 The corresponding Course No.	Plasma Physics (3) Particle Accelerator Physics I (3) Particle Accelerator Physics II(3) Plasma/Accelerator Physics-related special topics*

[MS/PhD 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 and at least 27 of which must be research credits.

B. MS/PhD Integrated Program required subject is the same as Doctoral Program.

* 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 & Lab Rotation 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. 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/PhD integrated program.

D. Department of Humanities & Social Sciences opens the university's common English subjects for graduate students, Scientific Writing (GEDU501) and Research Paper Presentation Skill (GEDU 502), which are recognized as a Free Elective subjects and graded on an S/U basis. These subjects are graded on an S/U basis, so they are not included in graduation credits.

3. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing	Graded on an S/U basis, Not included in graduation credits
			Free Elective	Research Paper Presentation Skill	
			Free Elective	Research Ethics	
			Major Requirement	Current Trends in Chemistry	Another Department Subjects (500-level to 800-level graduate courses, excluding seminar courses), If the student wishes to have the credit acknowledged, choose to be evaluated on a letter-grade basis.
			Major Elective	Electrochem. for Energy Applications	
			Major Elective	Applied Numerical Methods	
			Major Elective	Transducer Theory & Its Applications	
			Major Elective	Acoustics	
			Major Elective	Adv. Thermodynamics	
			Major Elective	A Study on Interplays of Human & Tech.	
			Major Elective	Conv. Imagination & Design Thinking of Eng.	
			Major Elective	Intro. to Environmental Eng.	
			Major Requirement	Artificial Intelligence & Data Science	
Dept.	Core Requirements		Major Requirement	Analytical Mechanics	
			Major Requirement	Electrodynamics I	
			Major Requirement	Quantum Mechanics I	
			Major Requirement	Statistical Mechnics	
			Major Requirement	Colloquium	Graded on an S/U basis, Up to 3 credits included in graduation credits
	Core Requirements (Electives)		Major Requirement	Electrodynamics II	◎ 6 credits required * The Graduate Studies Committee shall determine whether or not to accept the completion. * Only the credits took after entering the Graduate Course are accepted. ◎ Lab Rotation (Graded on an S/U basis, Included in graduation credits)
			Major Requirement	Quantum Mechanics II	
			Major Elective	Lab Rotation	
	Core Electives (Requirements by Field)	Condensed Matter Physics	Major Elective	Solid State Physics (undergraduate)	
			Major Elective	Solid State Physics I	
			Major Elective	Solid State Physics II	
			Major Elective	Many Body Theory	
			Major Elective	Phase Transition and Critical Phenomena	
			Major Elective	Condensed Matter Physics-related special topics	
		Particle Physics	Major Elective	Nuclear and Elementary Particle Physics (undergraduate)	
			Major Elective	Quantum Mechanics III	
			Major Elective	Elementary Particle Physics	
			Major	Quantum Field Theory	

Classification			Category	Course Title	Remarks
			Elective		
			Major Elective	Theory of Relativity	
			Major Elective	Particle Physics-related special topics	
		Optics/ Atomic Physics	Major Elective	Optical Physics (undergraduate)	
			Major Elective	Advanced Optics	
			Major Elective	Quantum Optics	
			Major Elective	Optics/Atomic Physics-related special topics	
		Biophysics	Major Elective	Biological Physics (undergraduate)	
			Major Elective	Quantitative Theoretical Biology	
			Major Elective	Biophysics-related special topics	
		Plasma/ Accelerator	Major Elective	Plasma Physics (undergraduate)	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (Requirements by Field)	Physics	Major Elective	Particle Accelerator Physics I	
			Major Elective	Particle Accelerator Physics II	
			Major Elective	Plasma/Accelerator Physics-related special topics	
	Core Electives	Common	Major Elective	Advanced Mechanics	
			Major Elective	Advanced Statistical Mechanics	
			Major Elective	Computational Physics Lab.	
			Major Elective	Advanced Physics Lab.	
			Major Elective	Plasma Physics I	
			Major Elective	Plasma Physics II	
			Major Elective	Computational Physics	
			Major Elective	Surface Physics	
			Major Elective	Magnetism	
			Major Elective	Vacuum Physics & Technology	
			Major Elective	Superconductivity	
			Major Elective	Biological Statistical Physics	
			Major Elective	Nonlinear Dynamics and Chaos Theory	
			Major Elective	Physics of Soft Condensed Matter	
			Major Elective	Plasma Diagnostic	
			Major Elective	Low Temperature Plasma Physics	

Classification			Category	Course Title	Remarks
			Major Elective	Introduction to Synchroton Radiation Applications	
			Major Elective	Accelerator Technology	
			Major Elective	Laser Physics	
			Major Elective	Master Thesis Research	Graded on an S/U basis, Included in graduation credits
			Major Elective	Extramural Research Internship	
			Major Elective	Doctoral Dissertation Research	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

4. Departmental Curriculum Roadmap

Major	Category	Course Title
Condensed Matter Physics	Common Course	Scientific Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochem. for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Adv. Thermodynamics, A Study on Interplays of Human & Tech., Conv. Imagination & Design Thinking of Eng., Intro. to Environmental Eng., Artificial Intelligence & Data Science
	Dept. Core Requirements	Analytical Mechanics, Electrodynamics I, Quantum Mechanics I, Statistical Mechnics, Colloquium
	Dept. Core Requirements (Electives)	Electrodynamics II, Quantum Mechanics II, Lab Rotation
	Dept. Core Electives (Requirements)	Solid State Physics (undergraduate), Solid State Physics I, Solid State Physics II, Many Body Theory, Phase Transition and Critical Phenomena, Condensed Matter Physics-related special topics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Particle Physics	Common Course	Scientific Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochem. for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Adv. Thermodynamics, A Study on Interplays of Human & Tech., Conv. Imagination & Design Thinking of Eng., Intro. to Environmental Eng., Artificial Intelligence & Data Science
	Dept. Core Requirements	Analytical Mechanics, Electrodynamics I, Quantum Mechanics I, Statistical Mechnics, Colloquium
	Dept. Core Requirements (Electives)	Electrodynamics II, Quantum Mechanics II, Lab Rotation
	Dept. Core Electives (Requirements)	Nuclear and Elementary Particle Physics (undergraduate), Quantum Mechanics III, Elementary Particle Physics, Quantum Field Theory, Theory of Relativity, Particle Physics-related special topics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Optics/Atomic Physics	Common Course	Scientific Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochem. for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Adv. Thermodynamics, A Study on

Major	Category	Course Title
		Interplays of Human & Tech., Conv. Imagination & Design Thinking of Eng., Intro. to Environmental Eng., Artificial Intelligence & Data Science
	Dept. Core Requirements	Analytical Mechanics, Electrodynamics I, Quantum Mechanics I, Statistical Mechnics, Colloquium
	Dept. Core Requirements (Electives)	Electrodynamics II, Quantum Mechanics II, Lab Rotation
	Dept. Core Electives (Requirements)	Optical Physics (undergraduate), Advanced Optics, Quantum Optics, Optics/Atomic Physics-related special topics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Biophysics	Common Course	Scientific Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochem. for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Adv. Thermodynamics, A Study on Interplays of Human & Tech., Conv. Imagination & Design Thinking of Eng., Intro. to Environmental Eng., Artificial Intelligence & Data Science
	Dept. Core Requirements	Analytical Mechanics, Electrodynamics I, Quantum Mechanics I, Statistical Mechnics, Colloquium
	Dept. Core Requirements (Electives)	Electrodynamics II , Quantum Mechanics II, Lab Rotation
	Dept. Core Electives (Requirements)	Biological Physics (undergraduate), Quantitative Theoretical Biology, Biophysics-related special topics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Plasma/ Accelerator Physics	Common Course	Scientific Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochem. for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Adv. Thermodynamics, A Study on Interplays of Human & Tech., Conv. Imagination & Design Thinking of Eng., Intro. to Environmental Eng., Artificial Intelligence & Data Science
	Dept. Core Requirements	Analytical Mechanics, Electrodynamics I, Quantum Mechanics I, Statistical Mechnics, Colloquium
	Dept. Core Requirements (Electives)	Electrodynamics II, Quantum Mechanics II, Lab Rotation
	Dept. Core Electives (Requirements)	Plasma Physics (undergraduate), Particle Accelerator Physics I, Particle Accelerator Physics II, Plasma/Accelerator Physics-related special topics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

5. 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 Mechnics ······ (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 ······ (3-0-3)

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. ······ (2-2-3)

Topics include Shell programming, system calls in Unix and VAX/VMS environment, programming using C and MATLAB. Small computing projects selected from electromagnetism, quantum mechanics, statistical physics and mathematical physics are required to be completed.

PHYS521, 522 Solid State Physics Ⅰ, Ⅱ ······ (3-0-3)

Recommended Prerequisite: PHYS301, PHYS302, PHYS304, PHYS401

This course discusses at advanced level experimental and theoretical problems in solid state physics. Topics include electromagnetic, optical, thermal and transport properties of solids, energy band theory and Fermi surface, magnetism, and superconductivity.

PHYS551 Advanced Physics Laboratory ······ (0-6-3)

Carried out are experiments to provide students with experience in experimental methods in selected topics of modern physics. Topics may vary according to the interests of the students.

PHYS601 Quantum MechanicsⅢ ······ (3-0-3)

Recommended Prerequisite: PHYS505, PHYS506

An advanced level quantum mechanics course. Topics include the Klein-Gordon equation, the Dirac equation, second quantization, the Feynman diagram and its applications, and introductory quantum field theory.

PHYS606 Elementary Particle Physics ······ (3-0-3)

Classification of elementary particles and their interactions are covered. Gauge symmetry, standard model and theories beyond the standard model are introduced.

PHYS608, 609 Plasma Physics Ⅰ, Ⅱ ······ (3-0-3)

Various phenomena of charged particles in the electromagnetic field will be discussed. Topics include Coulomb collision and transport phenomena, motions of charged particles in magnetic fields, MHD theory, plasma confinement, various instabilities, and the plasma kinetic theory.

PHYS610 Many Body Theory ······ (3-0-3)

The theory on interacting particle systems will be covered. Topics include quantum field theoretic methods, Coulomb gas, imperfect Bose gas, Fermi liquid, magnetism, superconductivity, and nuclear matter.

PHYS611 Quantum Field Theory ······ (3-0-3)

Recommended Prerequisite: PHYS505, PHYS506, PHYS601

This course covers quantum electrodynamics (QED), quantum chromodynamics (QCD), re-normalization group theory, path integrals, and current topics in theoretical high energy physics.

PHYS612 Computational Physics ······ (2-2-3)

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

PHYS613 Theory of Relativity ······ (3-0-3)

The course covers the general relativity. After reviewing the special relativity, necessary tools in the differential geometry such as differential forms, curvature tensors are introduced. Einstein's field equation is derived. The black hole physics and the modern cosmology are discussed.

PHYS615, 616 Particle Accelerator Physics Ⅰ, Ⅱ ······ (3-0-3)

This course is about general theory of beam optics. Particle accelerators such as cyclotron, synchrotron, linear accelerator, storage ring are discussed. Particle beam sources such as ions, electron, and positron are dealt with.

PHYS650 Surface Physics ······ (3-0-3)

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

PHYS651 Magnetism ······ (3-0-3)

The theory of magnetism in conductor, semiconductor and insulator is covered. The foundational principles and the applications of the magnetic phenomena are discussed.

PHYS652 Vacuum Physics & Technology ······ (3-0-3)

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

PHYS653 Superconductivity ·· (3-0-3)

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

PHYS662 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.

PHYS820 Lab Rotation ··· (0-6-3)

In order to expand the scope of academic research among laboratories and promote joint research, students shall participate in each of the three laboratories for one month.

PHYS890 Extramural Research Internship ·········· (1~4)

It encourages graduate students to participate in research through international exchanges so that they can develop their global capabilities.

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.

GEDU501 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.

GEDU502 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.

ICEC501 Research Ethics ·········· (1-0-1)

Research Ethics for responsible research of POSTECH graduate students Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ·········· (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ·········· (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 scientific and 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 in engineering practice.

MECH526 Transducer Theory & Its Applications ······························· (3-1-3)

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

MECH531 Acoustics ······························· (3-0-3)

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.

CHEB621 Advanced Thermodynacis ······························· (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

[Cross-Listing Courses]

QIST511/PHYS511 Quantum Physics and Quantum Technology ········ (3-0-3)

QIST514/PHYS514 Introduction to Quantum Information Science ········ (3-0-3)

QIST533/PHYS533 Quantum Communication and Quantum Cryptography ········ (3-0-3)

QIST534/PHYS534 Quantum Sensing and Quantum Metrology ········ (3-0-3)

QIST535/PHYS535 Quantum Computing and Quantum Simulation ········ (3-0-3)

QIST647/PHYS647 Introduction to Quantum Algorithm ········ (3-0-3)

QIST648/PHYS648 Introduction to Atomic Physics ········ (3-0-3)

QIST649/PHYS649 Quantum Machine Learning of Many-body Systems ········ (3-0-3)

QIST654/PHYS654 Optical Spectroscopy for Quantum Materials ········ (3-0-3)

QIST655/PHYS655 Topological Materials Information Devices ········ (3-0-3)

QIST656/PHYS656 Introduction to Solid-State Quantum Microscopy ········ (3-0-3)

NUCE718M/PHYS682 Principles & Tech. on the Accelerators ········ (3-0-3)

NUCE719G/PHYS683 Intermediate Beam Physics ········ (3-0-3)

NUCE719K/PHYS715K ST: Adv. Understanding Synchrotron Rad. ········ (3-0-3)

NUCE719P/PHYS715P SP: Hands-on Accelerator Experiments I ········ (1-4-3)

Department of Chemistry

1. Program Overview

Students are obliged to follow academic regulations and requirements of the POSTECH graduate program. The following represents the required courses of each individual division and the ones commonly required

- Physical Chemistry: Should take at least two courses among Quantum Chemistry (CHEM510), Molecular Spectroscopy (CHEM513), Statistical Thermodynamics (CHEM613), and Chemical Dynamics (CHEM614).
- Organic Chemistry: Advanced Organic Chemistry (CHEM521).
- Inorganic Chemistry: Advanced Inorganic Chemistry I (CHEM531).
- Analytical Chemistry: Advanced Analytical Chemistry (CHEM541).
- Polymer Chemistry: No specific courses are required.
- Biochemistry: Advanced Chemical Biology (CHEM561).
- Biomedical Chemistry: Advanced Chemical Biology (CHEM561).

[Commonly Required]

- 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.
  · Master program: Should take at least 3 times
  · M.S-Ph.D integrated program: Should take at least 6 times
  · Ph.D program: Should take at least 3 times

[Criteria of credit recognition for undergraduate courses for chemistry graduate program]

promotion	Until 2018	Starting from 2019
Undergraduate Courses (Maximum 6 credits)	400 units (G or S/U)	200 ~ 400 units (G or S/U)

[Criteria of credit recognition for courses offered by other departments for chemistry graduate program]

If a student takes a graduate course offered by other departments (500 to 800 units) under the approval of a advisor. The grade can be marked as letter grade or S(satisfied) / U(unsatisfied).
(HSS courses do not count towards graduation.)

[Remarks on Course Requirements for CHEM Graduate Students]

1) Scientific Writing for Graduate Students (GEDU501), Research Paper Presentation Skill (GEDU502)
   - They are not counted towards the graduation credit requirements.

2) Research Ethics (ICEC501)
   - For the Class of 2023 and later: It is a mandatory course but not included in the graduation credit requirements.
   - For the Class of 2022 and earlier: It is a recommended course but not counted towards the graduation credit requirements.

[Credits Required for Graduation]

Programs	Course Credit	Research Credit	Overall Credit
M.S.	12 Credits	16 Credits	28 Credits
Ph.D	12 Credits	30 Credits	42 Credits
Ms-Ph.D Integrated	18 Credits	42 Credits	60 Credits

[M.S. program]

A student can be qualified as M.S. by submitting his/her thesis, under completing the chemistry graduation curriculum properly. The proposal for the thesis should be submitted to and approved by the thesis committee members at least one semester before submitting the thesis. The thesis should be written in compliance with the university regulations and approved by the committee. In the special case such as change of advisor, the submission of the proposal for the thesis can be performed on the last semester under approval of the current professor. However, the thesis approval by the committee cannot be done within a month from the date of the proposal submission.

[Ph.D. program]

A student can be qualified as Ph.D. by submitting his/her dissertation, under completing the chemistry graduation curriculum properly. He/she must complete specific course recognized as Ph.D. candidate qualifying examination with a grade of A- or higher. Also, a student must obtain approval for dissertation proposal from dissertation committee members. The dissertation should be written in compliance with the university regulations and approved by the dissertation committee.

[M.S.-Ph.D. integrated program]

Students in integrated program do not need to submit a Master's thesis. A student must complete specific course recognized as Ph.D. candidate qualifying examination with a grade of A- or higher. Also, a student must obtain approval for dissertation proposal from dissertation committee members. The dissertation should be written in compliance with the university regulations and approved by the dissertation committee.

2. Course Overview

Category	Course No.	Course Title	Lecture-Exercise(Experiment)-Credit	Remarks (Recommended/ Prerequisite Courses)
Common Subjects	CHEM500 CHEM600 CHEM601	Current Trends in Chemistry Critical Review on Chemical Research Special Topics in Chemistry	3-0-3 3-0-3 variable credit	
Major Required	CHEM510	Quantum Chemistry	3-0-3	Physical Chemistry
	CHEM513	Molecular Spectroscopy	3-0-3	Physical Chemistry
	CHEM521	Advanced Organic Chemistry	3-0-3	Organic Chemistry
	CHEM531	Advanced Inorganic Chemistry Ⅰ	3-0-3	Inorganic Chemistry
	CHEM541	Advanced Analytical Chemistry	3-0-3	Chemical Analysis
	CHEM561	Advanced Chemical Biology	3-0-3	Biochemistry
	CHEM613	Statistical Thermodynamics	3-0-3	Physical Chemistry
	CHEM614	Chemical Dynamics	3-0-3	Physical Chemistry
Major Elective	CHEM511	Experimental Physical Chemistry	3-0-3	Physical Chemistry
	CHEM522	Organic Reaction Chemistry	3-0-3	Organic Chemistry
	CHEM532	Advanced Inorganic Chemistry Ⅱ	3-0-3	Inorganic Chemistry
	CHEM535	Physical Methods in Inorganic Chemistry	3-0-3	Physical Chemistry, Inorganic Chemistry
	CHEM542	Analytical Spectroscopy	3-0-3	Chemical Analysis
	CHEM543	Electrochemistry	3-0-3	Chemical Analysis
	CHEM544	Chemical Separation	3-0-3	Chemical Analysis
	CHEM551	Synthesis and Characterization of Macromolecules	3-0-3	Macromolecular Chemistry
	CHEM552	Morphology and Properties of Macromolecules	3-0-3	Macromolecular Chemistry
	CHEM571	Environmental Chemistry	3-0-3	
	CHEM612	Advanced Quantum Chemistry	3-0-3	Physical Chemistry
	CHEM616	Surface Chemistry	3-0-3	Physical Chemistry
	CHEM617	Computational Chemistry	3-0-3	Physical Chemistry
	CHEM618	Special Topics in Physical Chemistry	3-0-3	Physical Chemistry
	CHEM619	Nanochemistry	3-0-3	General Chemistry
	CHEM621	Organometallic Chemistry	3-0-3	Organic Chemistry, Inorganic Chemistry
	CHEM622	Medicinal Chemistry	3-0-3	Organic Chemistry
	CHEM623	Physical Organic Chemistry	3-0-3	Organic Chemistry, Physical Chemistry
	CHEM624	Organic Synthesis Chemistry	3-0-3	Organic Chemistry
	CHEM625	Natural Products and Bioorganic Chemistry	3-0-3	Organic Chemistry
	CHEM626	Enzyme Chemistry	3-0-3	Organic Chemistry
	CHEM627	Spectroscopic Determination of Molecular Structure	3-0-3	Organic Chemistry
	CHEM629	Special Topics in Organic Chemistry A-D	3-0-3	Organic Chemistry
	CHEM631	Bioinorganic Chemistry	3-0-3	Inorganic Chemistry
	CHEM632	Supramolecular Chemistry	3-0-3	Inorganic Chemistry
	CHEM633	Materials Chemistry	3-0-3	Inorganic Chemistry
	CHEM634	Solid State Chemistry	3-0-3	Inorganic Chemistry
	CHEM636	Nano-Surface Chemistry	3-0-3	Inorganic Chemistry
	CHEM639	Special Topics in Inorganic Chemistry A-D	3-0-3	Inorganic Chemistry
	CHEM642	Chemical Instrumentation	3-0-3	Chemical Analysis
	CHEM649	Special Topics in Analytical Chemistry A-D	3-0-3	Chemical Analysis

Category	Course No.	Course Title	Lecture-Exercise(Experiment)-Credit	Remarks (Recommended/ Prerequisite Courses)
Major Elective	CHEM651	Macromolecular Physical Chemistry	3-0-3	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
	CHEM652	Biopolymer Chemistry	3-0-3	Macromolecular Chemistry
	CHEM659	Special Topics in Macromolecular Chemistry	3-0-3	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
	CHEM669	Special Topics in Biochemistry	3-0-3	Biochemistry
	CHEM711	Theoretical Background for Computer Simulations of Biological Systems	3-0-3	Physical Chemistry II, Statistical Thermodynamics
	CHEM712	Computational Methods in Condensed Matter System	3-0-3	Solid State Physics, Quantum Chemistry
	CHEM714	Dynamics of Elementary Gas Reactions	3-0-3	Experimental Physical Chemistry
	CHEM715	Atomic and Molecular Theory of Surfaces	3-0-3	Experimental Physical Chemistry
	CHEM716	Multiple Quantum NMR Spectroscopy	3-0-3	Experimental Physical Chemistry
	CHEM717	Femtosecond Chemistry	3-0-3	Experimental Physical Chemistry
	CHEM718	Computer Aided Molecular Design	3-0-3	Experimental Physical Chemistry
	CHEM719	Dynamics of Mass Spectrometry	3-0-3	Experimental Physical Chemistry
	CHEM721	Biological Molecular Chemistry	3-0-3	Advanced Organic Chemistry
	CHEM722	Applied Bioorganic Chemistry	3-0-3	Advanced Organic Chemistry
	CHEM723	Asymmetric Organic Synthesis	3-0-3	Advanced Organic Chemistry
	CHEM724	Enzymes in Organic Synthesis	3-0-3	Advanced Organic Chemistry
	CHEM725	Molecular Recognition Chemistry	3-0-3	Advanced Organic Chemistry
	CHEM726	Organometallics in Organic Synthesis	3-0-3	Advanced Organic Chemistry
	CHEM735	Model Studies in Metalloenzymes	3-0-3	Advanced Inorganic Chemistry
	CHEM736	Homogeneous Catalysis	3-0-3	Advanced Inorganic Chemistry
	CHEM741	Applied Electrochemistry	3-0-3	Advanced Analytical Chemistry
	CHEM742	Analytical Vibrational Spectroscopy	3-0-3	Advanced Analytical Chemistry
	CHEM743	Bioanalytical Chemistry	3-0-3	Advanced Analytical Chemistry
	CHEM754	Physical Properties of Macromolecular Solutions	3-0-3	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
	CHEM755	Speciality Macromolecules	3-0-3	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
	CHEM761	Nucleic Acid Chemistry	3-0-3	Advanced Chemical Biology
Research Credits	CHEM699 CHEM801 CHEM809 CHEM899	Master Thesis Research Literature Seminar A/B Colloquium Doctoral Dissertation Research		
Common Subjects (Univ.)	GEDU501	Scientific Writing	3-0-2	**Not counted towards graduation credit requirements**
	GEDU502	Research paper Presentation Skill	3-0-2	
	ICEC501	Research Ethics	1-0-1	Mandatory for the Class of 2023 and later **(Not counted towards graduation credit requirements)**
	CHEM500	Current Trends in Chemistry	3-0-3	
	AMSE513	Electrochem. for Energy Applications	3-0-3	
	MECH505	Applied Numerical Methods	3-0-3	
	MECH526	Theory and Applications of Electromechanical Energy Conversion	3-1-3	
	MECH531	Acoustics	3-0-3	

Category	Course No.	Course Title	Lecture-Exercise(Experiment)-Credit	Remarks (Recommended/ Prerequisite Courses)
Common Subjects (Univ.)	CHEB621	Advanced Thermodynamics	3-0-3	
	CITE611	A Study on Interplays of Humanities and Technology	3-0-3	
	CITE612	Convergence Imagination & Design Thinking of Engineering	3-0-3	
	EVSE510	Introduction to Environmental Engineering	3-0-3	
	AIGS537	Artificial Intelligence & Data Science	3-0-3	

3. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks (Recommended/ Prerequisite Courses)
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	**Not counted towards graduation credit requirements**
				Research Paper Presentation Skill	
				Research Ethics	Mandatory for the Class of 2023 and later (**Not counted towards graduation credit requirements)**
			Common Requirement	Current Trends in Chemistry	Required condition for graduation (**Not counted towards graduation credit requirements)**
			Major Elective	Electrochemistry for Energy Applications	
				Applied Numerical Methods	
				Theory and Applications of Electromechanical Energy Conversion	
				Acoustics	
				Advanced Thermodynamics	
				A Study on Interplays of Humanities and Technology	
				Convergence Imagination & Design Thinking of Engineering	
				Introduction to Environmental Engineering	
				Artificial Intelligence & Data Science	
Dept.	Core Requirements (or Electives)		Common Requirement	Current Trends in Chemistry	Required condition for graduation (**Not counted towards graduation credit requirements)**
			Common Elective	Critical Review on Chemical Research	
	Core Electives (by Major)	Physical Chem.	Major Requirement	Quantum Chemistry	•Recommended prerequisite course: Physical Chemistry •Students should take at least 2 courses among the 4
				Molecular Spectroscopy	
				Statistical Thermodynamics	
				Chemical Dynamics	
			Major Elective	Experimental Physical Chemistry	Physical Chemistry
				Advanced Quantum Chemistry	Physical Chemistry
				Surface Chemistry	Physical Chemistry
				Computational Chemistry	Physical Chemistry
				Special Topics in Physical Chemistry A-D	Physical Chemistry
				Nanochemistry	General Chemistry
				Theoretical Background for Computer Simulations of Biological Systems	Physical ChemistryII, Statistical Thermodynamics
				Computational methods in condensed matter system	Solid State Physics, Quantum Chemistry
				Dynamics of Elementary Gas Reactions	Experimental Physical Chemistry
				Atomic and Molecular Theory of Surfaces	Experimental Physical Chemistry
				Multiple Quantum NMR Spectroscopy	Experimental Physical Chemistry
				Femtosecond Chemistry	Experimental Physical Chemistry
				Computer Aided Molecular Design	Experimental Physical Chemistry
				Dynamics of Mass Spectrometry	Experimental Physical Chemistry
		Organic Chem.	Major Requirement	Advanced Organic Chemistry	Organic Chemistry
			Major Elective	Organic Reaction Chemistry	Organic Chemistry
				Organometallic Chemistry	Organic Chemistry, Inorganic Chemistry
				Medicinal Chemistry	Organic Chemistry

Classification			Category	Course Title	Remarks (Recommended/ Prerequisite Courses)
Dept.	Core Electives (by Major)	Organic Chem.	Major Elective	Physical Organic Chemistry	Organic Chemistry, Physical Chemistry
				Organic Synthesis Chemistry	Organic Chemistry
				Natural Products and Bioorganic Chemistry	Organic Chemistry
				Enzyme Chemistry	Organic Chemistry
				Spectroscopic Determination of Molecular Structure	Organic Chemistry
				Special Topics in Organic Chemistry A-D	Organic Chemistry
				Biological Molecular Chemistry	Advanced Organic Chemistry
				Applied Bioorganic Chemistry	Advanced Organic Chemistry
				Asymmetric Organic Synthesis	Advanced Organic Chemistry
				Enzymes in Organic Synthesis	Advanced Organic Chemistry
				Molecular Recognition Chemistry	Advanced Organic Chemistry
				Organometallics in Organic Synthesis	Advanced Organic Chemistry
		Inorganic Chem.	Major Requirement	Advanced Inorganic Chemistry I	Inorganic Chemistry
			Major Elective	Advanced Inorganic Chemistry II	Inorganic Chemistry
				Physical Methods in Inorganic Chemistry	Physical Chemistry, Inorganic Chemistry
				Bioinorganic Chemistry	Inorganic Chemistry
				Supramolecular Chemistry	Inorganic Chemistry
				Materials Chemistry	Inorganic Chemistry
				Solid State Chemistry	Inorganic Chemistry
				Nano-Surface Chemistry	Inorganic Chemistry
				Special Topics in Inorganic Chemistry A-D	Inorganic Chemistry
				Model Studies in Metalloenzymes	Advanced Inorganic Chemistry
				Homogeneous Catalysis	Advanced Inorganic Chemistry
		Analytical Chem.	Major Requirement	Advanced Analytical Chemistry	Analytical Chemistry
			Major Elective	Analytical Spectroscopy	Analytical Chemistry
				Electrochemistry	Analytical Chemistry
				Chemical Separation	Analytical Chemistry
				Chemical Instrumentation	Analytical Chemistry
				Special Topics in Analytical Chemistry A-D	Analytical Chemistry
				Applied Electrochemistry	Advanced Analytical Chemistry
				Analytical Vibrational Spectroscopy	Advanced Analytical Chemistry
				Bioanalytical Chemistry	Advanced Analytical Chemistry
		Polymer Chem.	Major Elective	Synthesis and Characterization of Macromolecules	Macromolecular Chemistry
				Morphology and Properties of Macromolecules	Macromolecular Chemistry
				Macromolecular Physical Chemistry	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
				Biopolymer Chemistry	Macromolecular Chemistry

Classification			Category	Course Title	Remarks (Recommended/ Prerequisite Courses)
Dept.	Core Electives (by Major)	Polymer Chem.	Major Elective	Special Topics in Macromolecular Chemistry	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
				Physical Properties of Macromolecular Solutions	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
				Speciality Macromolecules	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules
		Biochemistry	Major Requirement	Advanced Chemical Biology	Biochemistry
			Major Elective	Special Topics in Biochemistry	Biochemistry
				Nucleic Acid Chemistry	Advanced Chemical Biology
		Biomedical Chem.	Major Requirement	Advanced Chemical Biology	Biochemistry
			Major Elective	Advanced Organic Chemistry	Organic Chemistry
				Medicinal Chemistry	Organic Chemistry
				Natural Products and Bioorganic Chemistry	Organic Chemistry
				Enzyme Chemistry	Organic Chemistry
				Special Topics in Biochemistry	Biochemistry
Dept.	Common Subjects		Major Elective	Environmental Chemistry, Special Topics in Chemistry	
			Research Subjects	Master Thesis Research (S/U)	Master's Program
				Literature Seminar A/B (S/U)	
				Colloquium (S/U)	•M.S. and Ph.D Program: Student should take this course at least 3 different times •M.S-Ph.D Integrated Program: Student should take this course at least 6 different times
				Doctoral Dissertation Research (S/U)	•Ph.D Program •M.S-Ph.D Integrated Program
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

4. Departmental Curriculum Roadmap

Major	Category		Course Title
Physical Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Quantum Chemistry, Molecular Spectroscopy, Statistical Thermodynamics, Chemical Dynamics (Choice of 2 among the 4)
		Major Elective	Experimental Physical Chemistry, Advanced Quantum Chemistry, Surface Chemistry, Computational Chemistry, Special Topics in Physical Chemistry A-D, Nanochemistry, Theoretical Background for Computer Simulations of Biological Systems, Computational methods in condensed matter system, Dynamics of Elementary Gas Reactions, Atomic and Molecular Theory of Surfaces, Multiple Quantum NMR Spectroscopy, Femtosecond Chemistry, Computer Aided Molecular Design, Dynamics of Mass Spectrometry
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Organic Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Advanced Organic Chemistry
		Major Elective	Organic Reaction Chemistry, Organometallic Chemistry, Medicinal Chemistry, Physical Organic Chemistry, Organic Synthesis Chemistry, Natural Products and Bioorganic Chemistry, Enzyme Chemistry, Spectroscopic Determination of Molecular Structure, Special Topics in Organic Chemistry A-D Special Topics in Organic Chemistry A-D, Biological Molecular Chemistry, Applied Bioorganic Chemistry, Asymmetric Organic Synthesis, Enzymes in Organic Synthesis, Molecular Recognition Chemistry, Organometallics in Organic Synthesis
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Inorganic Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Advanced Inorganic Chemistry Ⅰ
		Major Elective	Advanced Inorganic Chemistry Ⅱ, Physical Methods in Inorganic Chemistry, Bioinorganic Chemistry, Supramolecular Chemistry, Materials Chemistry, Solid State Chemistry, Nano-Surface Chemistry, Special Topics in Inorganic Chemistry A-D, Model Studies in Metalloenzymes, Homogeneous Catalysis
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Analytical Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Advanced Analytical Chemistry
		Major Elective	Analytical Spectroscopy, Electrochemistry, Chemical Separation, Chemical Instrumentation, Special Topics in Analytical Chemistry A-D, Applied Electrochemistry, Analytical Vibrational Spectroscopy, Bioanalytical Chemistry
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)

Major	Category		Course Title
Polymer Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Elective	Synthesis and Characterization of Macromolecules, Morphology and Properties of Macromolecules, Macromolecular Physical Chemistry, Biopolymer Chemistry, Special Topics in Macromolecular Chemistry, Physical Properties of Macromolecular Solutions, Speciality Macromolecules
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Biochemistry	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Advanced Chemical Biology
		Major Elective	Special Topics in Biochemistry, Nucleic Acid Chemistry
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Biomedical Chem.	Dept. Core Required/ Electives		Current Trends in Chemistry (Required), Critical Review on Chemical Research
	Major Electives by major	Major Requirement	Advanced Chemical Biology
		Major Elective	Advanced Organic Chemistry, Medicinal Chemistry, Natural Products and Bioorganic Chemistry, Enzyme Chemistry, Special Topics in Biochemistry
	Interdisciplinary Electives		Courses offered by relevant departments (undergraduate and graduate)
Common Subjects	Research Subjects		•Colloquium (CHEM809): Commonly Required Course - Master program and Ph.D program: Should take at least 3 times - M.S-Ph.D integrated program: Should take at least 6 times •Master Thesis Research (CHEM699) •Doctoral Dissertation Research (CHEM899)
	Free Elective		Research Ethics: mandatory course for the Class of 2023 and later (not counted towards the graduation credit requirements)

※ Current Trends in Chemistry: Commonly Required Course (Does not be counted as the graduation credits)

5. 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 fundamentalsof 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 reacti- ons, 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 through 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 1 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 ··· (3-0-3)

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 ··· (3-0-3)

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

CHEM552 Morphology and Properties of Macromolecules ··· (3-0-3)

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 ··· (3-0-3)

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

CHEM571 Environmental Chemistry ··· (3-0-3)

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

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

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

CHEM601 Special Topics in Chemistry ··· (variable credit)

This course aimes to cover trends and tendencies of contemporary chemistry research. Schedule of this course is not ordinarily set as like regular courses.

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

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

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

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

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

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

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

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

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

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

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

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

CHEM619 Nanochemistry ······ (3-0-3)

Nanochemistry deals with syntheses of various nanomaterials and nanostructures and the characterizations thereof. This class intends to address syntheses and applications of recently developed nano-sized structures that include organics, semiconductors and metals. Students in this class shall understand recent nanoscience and nanotechnology, and thus develop capabilities leading principal researches at future careers in academia and industries.

CHEM621 Organometallic Chemistry ······ (3-0-3)

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 ······ (3-0-3)

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 ······ (3-0-3)

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 ········· **(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.

CHEM625 Natural Products and Bioorganic Chemistry ········· **(3-0-3)**

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 give students the detailed information about how to utilize the spectroscopic data for the structural determination of unknown organic compounds.

CHEM629 Special Topics in Organic Chemistry ········· **(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.

▣ University-designated common subjects

GEDU501 Scientific Writing for Graduate Students ··· (3-0-2)

This is a course in writing scientific papers in English. It is a 12-week, credit course for Gradaute 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.

GEDU502 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.

ICEC501 Research Ethics ·· (1-0-1)

For research integrity and social responsibility, students will learn ethics regarding research data and publications, bioethics, and the concept of research community.

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.

AMSE513 Electrochemistry for Energy Applications ··· (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ·· (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 scientific and 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 in engineering practice.

MECH526 Theory and Applications of Electromechanical Energy Conversion ····························· (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.

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.

CHEB621 Advanced Thermodynamics ······ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

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 five tracks: Structural Biology, Immunology, Molecular Medicine, Neuroscience and Plant Sciences. All graduate students are provided with recommended courses and professional guidance from their advisors in the track. Within each track synergistic effects are being maximized centered on research by encouraging active exchange between professors, researchers and students. An inter-organic educational system is built in among the tracks so that students can have easy access to other areas. The curriculum offered in each track provides the students within the track. However, the students in a certain track are not bound to the curriculum offered by the specific track, but are in fact encouraged to take courses offered in other tracks or in other departments as well depending on their academic or research interests.

2. Course Planning

Each track emphasizes different course work. Students should consult with their advisor before taking the classes. The Structural Biology track emphasizes Bioinformatics, Genomic Stability&Cancer, Structure-based drug development and Membrane Protein Science. The Immunology track requires courses in Pathogen&Biodefense, Microbiome and Cancer Immunology. The Molecular Medicine track emphasizes lectures on Stem Cell&Cancer Biology, Proteostasis&Organelle Dynamics and Epigenetics&Systems Biology. The Neuroscience track emphasizes Neural Circuits&Behavior, Neurodevelopmental&Psychiatric Disorders and Neurogenetics&Neurogenomics. Finally, the Plant Sciences track requires Biomass, Plant Immunity and Green Biotechnology. 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

Programs	Course Credit	Research Credit	Overall Credit
M.S	19 Credits	9 Credits	28 Credits
Ph.D	13 Credits	19 Credits	32 Credits
Integrative	28 Credits	32 Credits	60 Credits

5. Major Field Courses Listed by Category

Classification		Category	Course Title	Remarks
Univ.	Common Subjects	Free Elective	Scientific Writing for Graduate Students	
		Free Elective	Research Paper Presentation Skill for Graduate Students	
		Major Elective	Research Ethics	
		Major Elective	Current Trends in Chemistry	
		Major Elective	Electrochem. for Energy Applications	
		Major Elective	Applied Numerical Methods	
		Major Elective	Theory and Applications of Electromechanical Energy Conversion	
		Major Elective	Acoustics	
		Major Elective	Adv. Thermodynamics	
		Major Elective	A Study on Interplays of Human & Tech.	
		Major Elective	Conv. Imagination & Deshign Thinking of Eng.	
		Major Elective	Intro. to Environmental Eng.	
		Major Elective	Artificial Intelligence & Data Science	

Classification			Category	Course Title	Remarks
Dept. Life Sciences	Core Requirements (or Electives)		Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	In the case of master's and doctoral programs, except for integrated courses, required majors are not applicable.
	Core Electives (by Major)	Structural Biology	Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	
			Major Elective	Advanced Immunology, Cellular Signaling, Virology, Neurobiology, Advanced Developmental Biology, Plant Molecular Biology, Plant Physiology, Advanced Plant Cell Biology, Biomacromolecular Structures, Protein Crystallography, Bioinformatics, Protein Biochemistry, or Molecular Imaging	
		Immunology	Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	
			Major Elective	Advanced Immunology, Cellular Signaling, Virology, Biomacromolecular Structures, Molecular Imaging, Protein Crystallography, or Bioinformatics	
		Molecular Medicine	Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	
			Major Elective	Advanced Immunology, Cellular Signaling, Virology, Neurobiology, Advanced Developmental Biology, Plant Molecular Cell Biology, Plant Physiology, Advanced Plant Cell Biology, Biomacromolecular Structures, Protein Crystallography, Bioinformatics, Protein Biochemistry, Molecular Imaging, Molecular Embryology, or Advanced Plant Pathology	
		Neuroscience	Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	
			Major Elective	Cellular Signaling, Neurobiology, Advanced Developmental Biology, Bioinformatics, Molecular Imaging, or Molecular Embryology	
		Plant Sciences	Major Requirement	Take 2 out of the 3 Q.E. subject courses: Advanced Molecular Biology, Advanced Biochemistry and Advanced Cell Biology	
			Major Elective	Plant Molecular Biology, Plant Physiology, Plant Molecular Cell Biology, or Advanced Plant Pathology	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

※ In the list of major subjects, major subjects required in the field are reflected.

6. 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.

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.

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 unpresendent biological research performed with cells in living subjects and to develop new ways to diagnose diseases. Accordingly, the course is open to under and graduate students with diverse backgrounds, such as material science, and mechanical engineering and physics, as well as biological sciences, who wish to learn one of fastest-developing techniques for biological research and medical intervention.

LIFE515 Biology of Aging ······························· (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.

LIFE518 Advanced Epigenetics and RNA Biology ······ (3-0-3)

This course covers the following topics in depth: 1) the core concepts and fundamentals of epigenetics, 2) molecular players and mechanisms, 3) relevance to biology and diseases. The course consists of a series of lectures and student presentation/discussion on the topics chosen based on individuals' own interests.

LIFE531 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.

LIFE533 Experimental Physical Chemistry ······ (3-0-3)

The principal focus of this course is to provide the fundamentalsof 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.

LIFE534 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.

LIFE535 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.

LIFE536 Organic Reaction Chemistry ······ (3-0-3)

Many organic reactions including reactions with carbanions, organometallic reacti- ons, oxidation-reduction reactions, and cyclo-additions will be described in this course.

LIFE537 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.

LIFE541 Analytical Spectroscopy ······ (3-0-3)

This course provides a thorough treatment of the instrumental principles, terminology, methodology, and instrumentation 1 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.

LIFE543 Chemical Separation ······ (3-0-3)

This course covers principle, instrumentation, and applications of various separation techniques:

extraction, filtration, chromatography, electrophoresis, field-flow fractionation, and multi- dimensional separation methods.

LIFE544 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.

LIFE545 Morphology and Properties of Macromolecules ······ (3-0-3)

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

LIFE547 Advanced Chemical Biology ······ (3-0-3)

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.

LIFE567 Engineering Optimization ······ (3-0-3)

Mathematical formulation and its solution methods of optimization problems in chemical process are treated. Linear Programming, Nonlinear Programming, Mixed Integer Programming, multi variable optimization and constraints are dealt with practical examples.

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 mutagenensis, analysis of the effects of mutation, protein folding and stability, designing proteins and drugs, and industrial applications using protein engineering.

LIFE610 Advanced Enzymology·························· **(3-0-3)**

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······(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.

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.

LIFE613 Molecular Embryology······(3-0-3)

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

LIFE614 Neuroendocrinology······(3-0-3)

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

LIFE615 Cell Membrane Physiology······(3-0-3)

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

LIFE616 Biocommunications······(3-0-3)

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

LIFE617 Tissue Biochemistry······(3-0-3)

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

LIFE618 Proteomics & Molecular Networks ······ **(3-0-3)**

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

LIFE619 Bioinformatics ······ **(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.

LIFE639 Medicinal Chemistry ······ **(3-0-3)**

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.

LIFE642 Natural Products and Bioorganic Chemistry ··· (3-0-3)

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.

LIFE643 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.

LIFE644 Spectroscopic Determination of Molecular Structure ··· (3-0-3)

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

LIFE646 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.

LIFE654 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.

LIFE655 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.

LIFE656 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.

LIFE663 Advanced Biochemical Engineering ··· (3-0-3)

LIFE668 Advanced Polymer Engineering ··· (3-0-3)

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-morphogenesis, and the latest techniques and their results.

LIFE712 Plant-Environment Interaction ······ (3-0-3)

Through studies of academic papers this course explores in depth the latest research on the physiological, biochemical, and molecular biological regulation of the processes through which plants recognize and react to various environmental factors (light, temperature, moisture, gravity).

LIFE713 Advanced Plant Pathology ······ (3-0-3)

This course comprehensively explores the characterization and pathology of plant germs including viruses, bacteria, and fungi, these germs’interactions with plants, and the physiology and biochemistry of infected plants. The latest research on molecular biology will also be examined.

LIFE714 Methods in Cell Biology ······ (3-0-3)

In this course, students explores the cell biological experiment techniques needed to understand the structures and functions of advanced cells through lectures, presentations, and discussions.

LIFE715 Protein Crystallography ······ (3-0-3)

This course explores the theory and application of protein X-ray crystallography. Particular emphasis is placed on crystal symmetry, diffraction theory, multiple isomorphous replacement, and molecular replacement.

LIFE716 Methods in Immunology ······ (3-0-3)

This course explores the evolution of the immune system, concomitant immunity, new concepts of and strategies for vaccines, immune tolerance, and autoimmune diseases.

LIFE717 Methods in Virology ······ (3-0-3)

In this course, students explores the techniques and methods needed to conduct research on viruses and viral diseases through lectures and discussions on academic papers.

LIFE718 Techniques in Molecular Immunology ······ (1-4-3)

In this course, students explores immunological techniques used in the study of various life forms on the molecular level through lectures and experiments.

LIFE719 Molecular Biophysics ······ (3-0-3)

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

LIFE720 Chemical Carcinogenesis and Teratogenesis ························ (3-0-3)

This course explores the mechanisms through which chemicals cause disabilities in babies and cancer. In addition, students will examine the latest research on biochemistry, cellular biology, and molecular biology.

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.

LIFE737 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.

LIFE738 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.

LIFE740 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.

LIFE741 Molecular Recognition Chemistry ························ (3-0-3)

Focussed contents involve the molecular recognition phenomena in modeled and real molecular systems.

LIFE743 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.

LIFE747 Bioanalytical Chemistry ········ **(3-0-3)**

Principle, instrumentation, and applications of various, contemporary bioanalytical methods: biosensors, bioseparations, bio-mass spectrometries, nanobiotechnologies, and miniaturization techniques.

LIFE767 Bioseparation Processes ········ **(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.

LIFE769 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.

LIFE782 Physical Properties of PolymersI ········ **(3-0-3)**

A study on the correlation between the structures and properties of polymers. This course offers the various physical properties of polymer solutions, solid phase polymers, and liquid phase polymers theoretically. Lectures and practices on computer simulations are provided to enhance an understanding of the basic concepts on polymer structures and properties in molecular domains.

LIFE790 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.

LIFE801A-Z Special Topics in Chemical Engineering ········ **(3-0-3)**

New research trends in Chemical Engineering are introduced.

LIFE802A-Z Graduate Seminar ········ **(1-0-1)**

LIFE803A-Z Graduate Research ········ **(1-0-1)**

LIFE805 Colloquium ········ **(1-0-1)**

LIFE806A-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:

1. Electronic Materials for Information Technologies.
2. Materials for Energy and Environmental Technologies.
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 3 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.
- 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.
- 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.

[Remarks on Course Requirements for MSE Graduate Students]

Graduation requirements for each year of admission are as follows.

▣ GEDU501(Scientific Writing for Graduate Students)

- Before the 2021 academic year number: It is recommended to take the course and it is included in the graduation credits.
- After and including the 2022 academic year number: Must take courses and it is included in the graduation credits.
- Among international graduate students, those who are deemed to have sufficient English proficiency may be exempted from the mandatory enrollment requirement with prior interview and approval from their academic advisor. (Effective starting with graduates of February 2026.)
- If you completed GEDU501 during a master's course, you do not need to register for this course.
- Credits earned with an S grade in GEDU501 shall not be included in the maximum 6-credit limit

applicable to the following:
1) Graduate courses from other departments taken with an S/U grade; and
2) 300- and 400-level undergraduate courses taken for credit toward graduate program requirements.

▣ **ICEC501(Research Ethics)**
- Before the 2022 academic year number: It is recommended to take the course and it is not included in the graduation credits.
- After and including the 2023 academic year number: Must take courses and it is not included in the graduation credits.
- If you completed ICEC501 during a master's course, you do not need to register for this course.

[Credits required for graduation]

Master's Program		Doctoral Program		MS/PhD Integrated Program	
Course Credits	Research Credits	Course Credits	Research Credits	Course Credits	Research Credits
18	10	15	17	30	30

3. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	**Common Subjects**		Free Elective	Scientific Writing for Graduate Students	Mandatory Requirements: After and including the 2022 academic year
			Free Elective	Research Ethics	-Mandatory Requirements: After and including the 2023 academic year -Graduation credits not included
			Free Elective	Research Paper Presentation Skill	Graduation credits not included
			Major Elective	Current Trends in Chemistry	
			Major Elective	Electrochemistry for Energy Applications	
			Major Elective	Applied Numerical Methods	
			Major Elective	Theory and Applications of Electromechanical Energy Conversion	
			Major Elective	Acoustics	
			Major Elective	Advanced Thermodynamics	
			Major Elective	A Study on Interplays of Humanities and Technology	
			Major Elective	Convergence Imagination & Design Thinking of Engineering	
			Major Elective	Introduction to Environmental Engineering	
			Major Elective	Artificial Intelligence & data Science	
Dept.	Core Electives (by Major)	Fundamental Materials Science and Materials Characterization Technology	Major Elective	Advanced Thermodynamics of Materials	
			Major Elective	Phase Transformation	
			Major Elective	Research Method in Materials Science and Engineering	
			Major Elective	Atomic Simulation	
			Major Elective	Introduction to Electronic Structure Calculation Method	
			Major Elective	Atomic Structure Analysis	
			Major Elective	Dislocations and Strengthening Mechanisms	
			Major Elective	Solid State Reactions and Sintering	
			Major Elective	Solid State Physics	
			Major Elective	Statistical Mechanics of Materials	
			Major Elective	Electron Diffraction and Microscopy	
			Major Elective	Advanced Electron Microscopy	
			Major Elective	Experiments for Transmission Electron Microscopy	
			Major Elective	X-Ray Diffraction and Imaging	
			Major Elective	Applied Quantum Mechanics	
			Major Elective	Special Topics in Materials Science	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	Structural Material Technology	Major Elective	Deformation Processing of Structural Materials	
			Major Elective	Fracture Phenomena and Mechanisms	
			Major Elective	Special Topics in Metallurgical Engineering	
		Energy Technology	Major Elective	Noncrystalline Ceramics	
			Major Elective	Electrochemistry for Energy Applications	
			Major Elective	Photonics	
			Major Elective	Oxide Thin Film Materials and Devices	
			Major Elective	Special Topics in Ceramics	
		Information Technology	Major Elective	Inorganic Materials for Optoelectronics and Applications	
			Major Elective	Properties of Semiconducting Materials	
			Major Elective	Electrical Properties of Low Dimensional Materials	
			Major Elective	Special Topics in Electronic Materials	
		Biohybrid Technology	Major Elective	Polymer Engineering	
			Major Elective	Nucleic Acid Biomaterials and Nanobiotechnologies	
			Major Elective	Polymer Gels	
			Major Elective	Principles and Application of Printing Technology	
			Major Elective	NanoBiomaterials	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed
	Common Subjects		Research subject	Seminars in Materials Science	Mandatory Requirements: - Doctoral: 3 credits or more - MS/PhD Integrated: 3 credits or more
			Research subject	Master Thesis Research	
			Research subject	Doctoral Dissertation Research	

4. Departmental Curriculum Roadmap

Major	Category	Course Title
Fundamental Materials Science and Materials Characterization Technology	Common Course (Free Electives)	Scientific Writing for Graduate Students(Mandatory Requirements), Research Ethics(Mandatory Requirements), Research Paper Presentation Skill
	Common Course (Major Electives)	Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Theory and Applications of Electromechanical Energy Conversion, Acoustics, Advanced Thermodynamics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & data Science
	Major Electives by major	Advanced Thermodynamics of Materials, Phase Transformation, Research Method in Materials Science and Engineering, Atomic Simulation, Introduction to Electronic Structure Calculation Method, Atomic Structure Analysis, Dislocations and Strengthening Mechanisms, Solid State Reactions and Sintering, Solid State Physics, Statistical Mechanics of Materials, Electron Diffraction and Microscopy, Advanced Electron Microscopy, Experiments for Transmission Electron Microscopy, X-Ray Diffraction and Imaging, Applied Quantum Mechanics, Special Topics in Materials Science
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Structural Material Technology	Common Course (Free Electives)	Scientific Writing for Graduate Students(Mandatory Requirements), Research Ethics(Mandatory Requirements), Research Paper Presentation Skill
	Common Course (Major Electives)	Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Theory and Applications of Electromechanical Energy Conversion, Acoustics, Advanced Thermodynamics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & data Science
	Major Electives by major	Deformation Processing of Structural Materials, Fracture Phenomena and Mechanisms, Special Topics in Metallurgical Engineering
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Energy Technology	Common Course (Free Electives)	Scientific Writing for Graduate Students(Mandatory Requirements), Research Ethics(Mandatory Requirements), Research Paper Presentation Skill
	Common Course (Major Electives)	Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Theory and Applications of Electromechanical Energy Conversion, Acoustics, Advanced Thermodynamics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & data Science
	Major Electives by major	Noncrystalline Ceramics, Electrochemistry for Energy Applications, Photonics, Oxide Thin Film Materials and Devices, Special Topics in Ceramics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Information Technology	Common Course (Free Electives)	Scientific Writing for Graduate Students(Mandatory Requirements), Research Ethics(Mandatory Requirements), Research Paper Presentation Skill
	Common Course (Major Electives)	Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Theory and Applications of Electromechanical Energy Conversion, Acoustics, Advanced Thermodynamics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & data Science
	Major Electives by major	Inorganic Materials for Optoelectronics and Applications, Properties of Semiconducting Materials, Electrical Properties of Low Dimensional Materials, Special Topics in Electronic Materials
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Biohybrid Technology	Common Course (Free Electives)	Scientific Writing for Graduate Students(Mandatory Requirements), Research Ethics(Mandatory Requirements), Research Paper Presentation Skill
	Common Course (Major Electives)	Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Theory and Applications of Electromechanical Energy Conversion, Acoustics, Advanced Thermodynamics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & data Science
	Major Electives by major	Polymer Engineering, Nucleic Acid Biomaterials and Nanobiotechnologies, Polymer Gels, Principles and Application of Printing Technology, NanoBiomaterials
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Common Subjects	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate) - 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.
	Research subject	- Seminars in Materials Science (Mandatory Requirements: Doctoral & MS/PhD Integrated 3 credits or more) - Master Thesis Research - Doctoral Dissertation Research

5. Course Description

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

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

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

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

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

Polymer materials are produced and applied in huge amounts in Korea on the basis of petrochemistry. This course pursuits 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 Noncrystalline Ceramics ································· (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 ································· (3-0-3)

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.

AMSE511 Introduction to Electronic Structure Calculation Method ································· (3-1-3)

The aim of this course is providing in-depth understanding and hand-on experience on diverse quantum mechanical electronic structure calculation methods.

AMSE512 Atomic Structure Analysis ······························ **(3-1-3)**

The course covers the topic of transmission electron microscopy (TEM) used for quantitative structural studies, especially at the atomic level (electron crystallography). It includes determination of unit cell size, plane and space groups using different diffraction and high-resolution electron microscopy. In addition, the course covers the use of quantitative structural models directly from electron diffraction and from the images. The course also includes dynamic diffraction theory (block wave, dispersion surface, Kikuchi lines) and scanning transmission electron microscopy (STEM), which can be used for studying defect structures such as dislocations and nanomaterials.

AMSE513 Electrochemistry for Energy Applications ······························ **(3-0-3)**

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

AMSE522 Inorganic Materials for Optoelectronics and Applications ······························ **(3-0-3)**

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 ······························ **(3-0-3)**

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.

AMSE562 Polymer Gels ······························ **(3-0-3)**

This class deals with the fundamentals of the static and dynamic properties of polymer networks and gels. And it covers the synthesis and characterization of novel polymeric networks and gels such as hydrogels, ion gels, and gels of amphiphilic block copolymers. Also, the applications of gels such as the use of the gel medium for controlled drug delivery, encapsulation of proteins and enzymes, and biomimetic soft actuators will be introduced.

AMSE563 Principles and Application of Printing Technology ······························ **(3-0-3)**

This course is to provide a compresensive understanding on printing technology from materials to processes as well as its emerging applications.

AMSE601 Dislocations and Strengthening Mechanisms ························ **(3-0-3)**

The advanced concepts and application aspects of dislocations will be introduced first. The continuum theory of dislocations will be studied first in view of the internal stress fields, forces, and energies. The Green's function method is introduced to solve the stress fields of general curved dislocations. The crystallography of dislocations including the Peierls-Nabarro dislocation and partial dislocations will also be studied in this course followed by the single crystal plasticity. The various strengthening mechanisms are then studied especially in relation to the interaction between the barriers and dislocations. Finally, the recently developed internal variable theory of inelastic deformation will be introduced at the end of course.

AMSE604 Solid State Reactions and Sintering ························ **(3-0-3)**

This course covers the fundamentals of solid state reaction kinetics involved in crystalline and non-crystalline solid including metallic and ionic systems. Crystal defects and transport theories are discussed in depth as a basis of solid state reactions. A wide range of solid state reaction kinetics are addressed in quantitative manners. They include homogeneous reaction, inter-diffusion, solid-gas reactions, solid-solid reactions, fuel cells, galvanic cells, and sintering practice.

AMSE605 Solid State Physics ························ **(3-0-3)**

This course will present an introductory treatment of solid state physics. Topics to be discussed include; free electron model, nearly-free electron model, electromagnetic theory, band theory, defects, thermal and optical properties of materials, dielectrics and ferroelectrics, magnetism, and optoelectronic and spintronic devices.

AMSE606 Statistical Mechanics of Materials ························ **(3-0-3)**

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

AMSE608 Electron Diffraction and Microscopy ························ **(3-0-3)**

Introductory course which deals with electron waves, the structure of electron microscope, theories of electron diffraction, theories of diffraction contrast and phase contrast, and their applications to imaging of crystal structure, defects and phase transformation in current crystalline materials.

AMSE609 Advanced Electron Microscopy ························ **(3-0-3)**

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

AMSE611 Experiments for Transmission Electron Microscopy···(1-4-3)

Laboratory experiment course for the prerequisite course of AMSE608. The basic operation of transmission electron microscope, the practice for electron diffraction and imaging of crystalline defects are performed. High resolution imaging and analysis are also practiced with an aid of analytical microscopy EDS, STEM, EELS in current materials.

AMSE612 X-Ray Diffraction and Imaging·· (3-0-3)

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

AMSE613 Applied Quantum Mechanics·· (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.

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.

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.

AMSE649 Photonics ·· (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.

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.

AMSE669 NanoBiomaterials····· (3-0-3)

The convergence of recent advances in nanobiotechnology and medicine has created the new research field of nanomedicine. This course will provide students with an in-depth understanding of nanobiomaterials for nanomedicines including biosensors, medical imaging systems, drug delivery systems and regenerative medicines.

AMSE681 Properties of Semiconducting 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.

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. (Hence the class-takers are required to give a presentation on a given subject in a group setting.)

AMSE699 Masters 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.

AMSE701 Seminars in Materials Science····· (1-0-1)

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····· (1~3)

Selected topics in advanced materials science are lectured in this special course.

AMSE731 Special Topics in Metallurgical Engineering····· (3-0-3)

Selected topics in advanced metallurgical engineering are lectured in this special course.

AMSE741 Special Topics in Ceramics····· (3-0-3)

Selected topics in advanced ceramic materials are lectured in this special course.

AMSE742 Special Topics in Electronic Materials····· (3-0-3)

Selected topics in advanced electronic materials are lectured in this special course.

AMSE899 Doctoral Dissertation Research ······ (1~9)

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

[Common Subjects]

GEDU501 Scientific Writing for Graduate Students ······ (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified. Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill ······ (3-0-2)

The course will focus on professional presentations for international conferences. Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers. The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics ······ (1-0-1)

- Research Ethics for responsible research of POSTECH graduate students
- Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ······ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ······ (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 scientific and 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 in engineering practice.

MECH526 Theory and Applications of Electromechanical Energy Conversion ························ (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.

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.

CHEB621 Advanced Thermodynamics ·· (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

Department of Mechanical Engineering

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 three major categories of graduate research and education to cope with evolving research objectives and international trends.

1. Nano/Microscale Engineering
2. Biomedical Engineering
3. Future Energy/Mobility

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 Mechanical Engineering 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. All graduate students are required to take Scientific Writing(GEDU501)
   - Completion of this courses is required for graduation but not included in credit needed to graduate.

   * If you completed during a master's course, you do not need to register for this course.

   * Research Paper Presentation Skill (GEDU 502) is not mandatory for graduate students and not included in credit needed to graduate.

3. All graduate students are required to take **Research Ethics**(ICEC501)
   - Before the 2022 academic year number: It is recommended to take the course and it is not included in the graduation credits.
   - After and including the 2023 academic year number: Must take courses and it is not included in the graduation credits.
   - If you completed ICEC501 during a master's course, you do not need to register for this course.

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

Course	Graduate Research Seminar A	Graduate Research Seminar B
For whom	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	Ph.D. Program students who completed the 3th semester, Integrative Program students who completed the 5th semester
Topic	To analyse research trends and give a presentation after organizing them	To present your own research areas and plans

- This course is mandatory for the new students starting from 2014 Fall semester.
- This course is mandatory for Master's Program students.

5. 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

Category	Course No.	Course name	L-E-C
Course Electives	MECH501	Analytic Methods in Engineering	3-0-3
	MECH503	Signal, data, and system analysis	3-0-3
	MECH505	Applied Numerical Methods	3-0-3
	MECH507	Software practice for Mech. Engineers	1-2-2
	MECH510	Analytic Dynamics	3-0-3
	MECH511	Advanced Mechanical Vibrations	3-0-3
	MECH515	Continuum Mechanics	3-0-3
	MECH518	Computational Kinematics and Dynamics	3-0-3
	MECH522	Time Series and System Analysis	3-0-3
	MECH525	Advanced Automatic Control	3-0-3
	MECH526	Theory and Applications of Electromechanical Energy Conversion	3-1-3
	MECH527	Advanced Artificial Intelligence for Mechanical Engineering	3-0-3
	MECH528	Human-Robot Interface	3-0-3
	MECH531	Acoustics	3-0-3
	MECH532	Tissue Engineering for Mechanical Engineers	3-0-3
	MECH533	Applied Optics	3-0-3
	MECH534	Bio-Imaging Technology	3-0-3
	MECH535	Introduction to BioMEMS	3-0-3
	MECH536	Principles of Biomedical Opt. & Imaging	3-0-3
	MECH537	Personalized Medicine for Engineers	3-0-3
	MECH538	Medical Device Design Process	3-0-3
	MECH539	Advanced Nanoscale Fabrication and Manufacturing	3-0-3
	MECH540	Elasticity	3-0-3

Category	Course No.	Course name	L-E-C
Course Electives	MECH541	Mechanics of Composite Materials	3-0-3
	MECH544	Fracture Mechanics	3-0-3
	MECH550	Advanced Thermodynamics	3-0-3
	MECH560	Advanced Heat Transfer	3-0-3
	MECH562	Energy Conversion and Power Plant Technology	3-0-3
	MECH570	Advanced Fluid Dynamics	3-0-3
	MECH574	Capillary and Wetting Phenomena	3-0-3
	MECH575	Electrokinetics	3-0-3
	MECH578	Gas Dynamics	3-0-3
	MECH579	Introduction to Microfluidics	3-0-3
	MECH582	Optimum Design	3-0-3
	MECH583	Introduction to Finite Element Method	3-0-3
	MECH588	Theory of Mechanical Design	3-0-3
	MECH598	Bio Dynamics	3-0-3
	MECH621	Advanced Microelectromechanical Systems	3-0-3
	MECH624	Biofluid Mechanics	3-0-3
	MECH631	Scaling Laws and Biomimetics	3-0-3
	MECH635	Biological Materials: Structure and Mechanical Properties	3-0-3
	MECH639	Advanced Robotics Ⅰ	3-0-3
	MECH646	Nanobiotechnology	3-0-3
	MECH647	Bioengineering	3-1-3
	MECH650	Microscale Heat Transfer	3-0-3
	MECH655	Alternative Energy	3-0-3
	MECH661	Venture Business Based on Technology	1-0-1
	MECH674	Viscous Fluid Flow	3-0-3
	MECH678	Flow Visualization	3-0-3
	MECH679	Fundamentals of Wind Energy Engineering	3-0-3
	MECH686	Computational Fluid Mechanics	3-0-3
	MECH692	Experimental Methods for Thermo-Fluid Dynamics	1-3-3
	MECH701	Special Topics in Systems and Design A/Z	3-0-3
	MECH702	Special Topics in Mechanical Engineering	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
	MECH727	Advanced Topics in Robotics	3-1-3
	MECH736	Optimal Control	3-0-3
	MECH739	Advanced Robotics Ⅱ	3-0-3
	MECH741	Theory of Plates and Shells	3-0-3
	MECH743	Elastic Waves in Solids	3-0-3
	MECH745	Elasticity of Composite Materials	3-0-3

Category	Course No.	Course name	L-E-C
Course Electives	MECH747	Theory of Viscoelasticity	3-0-3
	MECH748	Plasticity	3-0-3
	MECH760	Convection Heat Transfer	3-0-3
	MECH761	Radiation Heat Transfer	3-0-3
	MECH762	Hydrodynamic Stability	3-0-3
	MECH769	Turbomachinery	3-0-3
	MECH771	Waves in Fluids	3-0-3
	MECH774	Turbulence	3-0-3
	MECH775	Two Phase Flow	3-0-3
	MECH783	Advanced Finite Element Method	3-0-3
	MECH808	Graduate Research Seminar A	1-0-1
	MECH809	Graduate Research Seminar B	1-0-1
Research Electives	MECH699	Master Thesis Research	Credits can vary
	MECH803	Mechanical Engineering Seminar I	1-0-1
	MECH804	Mechanical Engineering Seminar II	1-0-1
	MECH899	Doctoral Dissertation Research	Credits can vary
Common Subjects	GEDU501	Scientific Writing	3-0-2
	GEDU502	Research Paper Presentation Skill	3-0-2
	ICEC501	Research Ethics	1-0-1
	CHEM500	Current Trends in Chemistry	3-0-3
	AMSE513	Electrochem. for Energy Applications	3-0-3
	MECH505	Applied Numerical Methods	3-0-3
	MECH526	Theory and Applications of Electromechanical Energy Conversion	3-1-3
	MECH531	Acoustics	3-0-3
	CHEB621	Adv. Thermodynamics	3-0-3
	CITE611	A Study on Interplays of Human. & Tech.	3-0-3
	CITE612	Conv. Imagination & Design Thinking of Eng.	3-0-3
	EVSE510	Intro.to Environmental Eng.	3-0-3
	AIGS537	Artificial Intelligence &Data Science	3-0-3

3. Major Field Courses Listed by Category

Classification		Category	Course Title	Remarks
Univ.	Common Subjects	**Free Elective**	Scientific Writing for Graduate Students	Requirement subject (Graduation credit not accepted)
		Free Elective	Research Paper Presentation Skill	(Graduation credit not accepted)
		Free Elective	Research Ethics	Requirement subject (Graduation credit not accepted)
		Major Elective	Current Trends in Chemistry	
		Major Elective	Electrochem. for Energy Applications	
		Major Elective	Applied Numerical Methods	
		Major Elective	Theory and Applications of Electromechanical Energy Conversion	

Classification			Category	Course Title	Remarks
			Major Elective	Acoustics	
			Major Elective	Adv. Thermodynamics	
			Major Elective	A Study on Interplays of Human. & Tech.	
			Major Elective	Conv. Imagination & Design Thinking of Eng.	
			Major Elective	Intro.to Environmental Eng.	
			Major Elective	Artificial Intelligence &Data Science	
Dept. of Mechanical Engineering	Common Requirements		Major Requirement	Graduate Research Seminar A	Requirement subject (Master's program are excluded.)
			Major Requirement	Graduate Research Seminar B	Requirement subject (Master's program are excluded.)
			Major Requirement	Mechanical Engineering Seminar I (Research credits)	Requirement subject (Foreign students are excluded.)
			Major Requirement	Mechanical Engineering Seminar II (Research credits)	Requirement subject (Foreign students are excluded.)
	Core Electives		Major Elective	Analytical Methods in Engineering	
			Major Elective	Applied Numerical Methods	
			Major Elective	Continuum Mechanics	
	Core Electives (by Major)	Nano /Microscale Engineering	Major Elective	Theory and Applications of Electromechanical Energy Conversion	
			Major Elective	Introduction to BioMEMS	
			Major Elective	Elasticity	
			Major Elective	Advanced Microelectromechanical Systems	
			Major Elective	Theory of Plates and Shells	
			Major Elective	Plasticity	
		Biomedical Engineering	Major Elective	Tissue Eng. for Mechanical Engineers	
			Major Elective	Applied Optics	
			Major Elective	Bio-Imaging Technology	
			Major Elective	Introduction to BioMEMS	
			Major Elective	Principles of Biomedical Opt. & Imaging	
			Major Elective	Personalized Medicine for Engineers	
			Major Elective	Medical Device Design Process	
			Major Elective	Scaling Laws and Biomimetics	
		Future	Major	Advanced Automatic Control	

Classification			Category	Course Title	Remarks
			Elective		
			Major Elective	Advanced Artificial Intelligence for M.E.	
			Major Elective	Acoustics	
			Major Elective	Advanced Heat Transfer	
			Major Elective	Advanced Fluid Dynamics	
			Major Elective	Introduction to Finite Element Method	
			Major Elective	Theory of Mechanical Design	
		Energy/ Mobility	Major Elective	Advanced Robotics I	
			Major Elective	Microscale Heat Transfer	
			Major Elective	Flow Visualization	
			Major Elective	Experimental Methods for Thermo-Fluid Dynamics	
			Major Elective	Convection Heat Transfer	
			Major Elective	Turbulence	
			Major Elective	Two Phase Flow	
		etc. M.E	Major Elective	Courses offered by department of M. E. graduate	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

4. Departmental Curriculum Roadmap

Major	Category	Course Title
Nano/Microscale Engineering	**Dept. Core Required Electives**	Analytical Methods in Engineering, Applied Numerical Methods, Continuum Mechanics
	Major Electives by major	Theory and Applications of Electromechanical Energy Conversion, Introduction to BioMEMS, Elasticity, Advanced Microelectromechanical Systems, Theory of Plates and Shells, Plasticity
Biomedical Engineering	**Dept. Core Required Electives**	Analytical Methods in Engineering, Applied Numerical Methods, Continuum Mechanics
	Major Electives by major	Tissue Eng. for Mechanical Engineers, Applied Optics, Bio-Imaging Technology, Introduction to BioMEMS, Principles of Biomedical Opt. & Imaging, Personalized Medicine for Engineers, Medical Device Design Process, Scaling Laws and Biomimetics
Future Energy/Mobility	**Dept. Core Required Electives**	Analytical Methods in Engineering, Applied Numerical Methods, Continuum Mechanics
	Major Electives by major	Advanced Automatic Control, Advanced Artificial Intelligence for M.E., Acoustics, Advanced Heat Transfer, Advanced Fluid Dynamics, Introduction to Finite Element Method, Theory of Mechanical Design, Advanced Robotics I, Microscale Heat Transfer, Flow Visualization, Experimental Methods for Thermo-Fluid Dynamics, Convection Heat Transfer, Turbulence, Two Phase Flow

5. 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.

MECH503 Signal, data, and system analysis ······ **(3-0-3)**

This course teaches signal processing and numerical analysis methods by using a popular commercial Matlab software. The contents include How to use Matlab in computation and display; Matlab programming; Signal processing methods in both time domain and frequency domain; Numerical solution of differential equations; Linear algebra; 2D signal (image) processing; Basic image processing and simple deep learning methods.

MECH505 Applied Numerical Methods ······ **(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 scientific and 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 in 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

Fundamentals of continuum mechanics applied to the mechanical behavior of engineering materials. The kinematics of deformation, concepts of stress, and balance principles. Isotropic linear elasticity and isotropic linear thermal elasticity. Variational and energy methods. Linear viscoelasticity. An introduction to the mechanics of large deformation; nonlinear hyperelastic material behavior. Classical fluids. Plasticity.

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 stategy 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, Lyapunov stability theories and LQ problems are covered in this course.

MECH526 Theory and Applications of Electromechanical Energy Conversion ················ **(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)**

Prerequisite: ME AI(MECH437) or equivalent AI courses

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.

MECH528 Human-Robot Interface ············ **(3-0-3)**

Recommended Prerequisite : System Control

This course is designed for students with no prior knowledge of human-robot interfaces, targeting graduate students and senior undergraduates from various disciplines. It aims to provide them with the opportunity to learn foundational theories and practical skills necessary for conducting research in their fields using robots, as well as to develop their ability to write academic papers. Participants will learn the fundamentals of kinematics and control, which are essential to robotics, basic statistical methods for validating research involving robots, and scientific techniques for setting hypotheses and verifying research results. Through the use of haptic devices provided in the course, students will gain an understanding of hardware and acquire coding skills, culminating in a comprehensive project presentation that showcases what they have learned.

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.

MECH536 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.

MECH537 Personalized Medicine for Engineers ·········· **(3-0-3)**

Doctors have long known that people differ in susceptibility to disease and response to medicines. However, with little guidance for understanding and adjusting to individual differences, treatments developed have generally been standardized for the many, rather than the few. To overcome the current limitation, through this course, students will learn how engineering and science change medicines, what the benefits of personalized medicine are, and what the role of engineers in creating personalized medicine is.

MECH538 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.

MECH539 Advanced Nanoscale Fabrication and Manufacturing ·········· **(3-0-3)**

Prerequisite: Intro.to Nanoscale Science & Engineering

Nanoscale science and engineering involve refining the functional properties of materials, devices, or systems with at least one dimension in the 1-100 nm range. Recent advancements in nanoscience have revolutionized multiple fields, driving innovations in healthcare, energy, computing, and communications. This course explores cutting-edge technologies influenced by breakthroughs in nanoscale research, including nanoelectronics, nanooptics, nanophotonics, nanomagnetics, nanomechanical systems, and nanosensors. A key focus is on understanding the theory, design, fabrication, characterization, and application of various nanomaterials and nanostructures. The course also covers state-of-the-art nanofabrication techniques, including advanced lithography, atomic layer deposition (ALD), self-assembly methods, and emerging hybrid approaches that integrate top-down and bottom-up fabrication strategies. Furthermore, students will explore various applications enabled by nanoscale fabrication, such as high-performance optical components, next-generation semiconductor devices, advanced sensors, and bio-integrated nanotechnology. Through this, students will gain a comprehensive understanding of how nanofabrication techniques contribute to real-world technological advancements.

MECH540 Elasticity ·········· **(3-0-3)**

Prerequisite: Solid Mechanics

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 analysis are studied. Important boundary value problems including one-dimensional problems, anti-plane strain problems, plane problems, 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 theses concepts to engineering problems are considered. Analytical methods are applied for analysis of the crack tip stress field. Practical approaches for evaluating structural integrity of mechanical components are also introduced. A brief review is also given on essential features in creep fracture and dynamic fracture.

MECH550 Advanced Thermodynamics ······ **(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 potentila 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)**

Prerequisites: Fluid Mechanics, Analytical Methods in Engineering or Advanced Calculus

The aim of this course is to provide basic theoretical concepts and methods used in the cross-disciplinary field of microfluidics. The lectures enable the students to understand the foundation of the theory, to be able to use the theory as a practical tool, and to be able to read research papers about microfluidics and lab-on-a-chip systems. We will discuss (1) fundamental hydrodynamics, (2) basic solutions of steady-state and time-dependent flows, (3) equivalent circuit theory, (4) diffusion, (5) capillary effect, and (6) electrohydrodynamics including electroosmosis. Students have a chance for reviewing recent articles, if possible.

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 machine design, and lectures on axiomatic design and the theory of solving inventive problem. Through this course, you will learn about axiomatic design applicable to all design fields such as system design, material processing design, and product design, and apply the axiomatic design technique to design examples that occurred in the real industry. In addition, students learn about the theory of solving inventive problem(TRIZ) applicable to various fields such as mathematics and medicine as well as engineering, and derive solutions for various inventive problem examples through contradictory arrangement.

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)

Biofluid flow phenomena in nature are analyzed based on fluid dynamic principles. Blood flows in cardio-vascular system and respiratory flows in human are handled. Especially, the causes and early diagnosis of circulatory vascular diseases and their diagnosis are studied. In addition, In addition, the fluid-mechanical survival strategies of living organisms including plants, insects and animals, optimized through a long history of evolution in response to environmental changes.

MECH631 Scaling Laws and Biomimetics ··· (3-0-3)

The aim of this course is to provide an analytical tool for designing and characterizing micro- and macro-scale systems based on scaling laws and dimensional analysis. The application examples of scaling laws and dimensional analysis are discussed. And then, biological systems, including materials, structures, sensors, actuators and so on, are introduced. Recent progresses on biomimetic applications based on the fundamental mechanisms of biological systems and scaling laws are extensively covered. Students have a chance for reviewing recent articles and design/realize their own biomimetic systems.

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

Prerequisites: Solid Mechanics 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)

This lecture provides 1) mathematical knowledge for advanced level robotic manipulation including mathematical description of robot kinematics, redundancy and optimization, and 2) advanced robust control theories including H-infinity control, robust internal loop compensator, and passivity-based control.

By the end of the course, you should be able to:

- Understand how to mathematically describe robotic manipulators including redundant manipulators and parallel manipulators.
  - •Understand how to implement advanced robust controllers in robotic manipulators.

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.

MECH647 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 introduces microscopic description of heat transfer phenomena, from the viewpoint of transport of quasi-particles such as electrons, phonons, and photons. Students will learn how the well-recognized classical constitutive laws, *e.g.*, Fourier's law and Ohm's law, can be derived from the consideration of quasi-particle behavior.

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 various thermo-fluid flows. This 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 advanced experimental techniques for measuring flow velocity, temperature, pressure, and heat flux that are crucial in thermo-fluid fields. This course handles several experimental techniques 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. In addition, some of these experimental techniques are hand-on experienced through a range of laboratories.

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 very)

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 ································ **(3-0-3)**

Recommended Prerequisite: Heat Transfer or permission of the professor

Basic laws of radiation heat transfer and radiation properties of solid surfaces and media are examined. In particular, the course covers radiation heat transfer in an absorbing, scattering, and emitting medium and 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 ································ **(3-0-3)**

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

MECH769 Turbomachinery ································ **(3-0-3)**

Prerequisite: Fluid Mechanics

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

MECH771 Waves in Fluids ································ **(3-0-3)**

Prerequisites: Fluid Mechanics or permission of the professor

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

MECH774 Turbulence ······ (3-0-3)

Prerequisites: Advanced Fluid Mechanics or permission of the professor

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

MECH775 Two Phase Flow ······ (3-0-3)

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 ······ (3-0-3)

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 ······ (1-0-1)

MECH804 Mechanical Engineering Seminar Ⅱ ······ (1-0-1)

MECH808 Graduate Research Seminar A ······ (1-0-1)

MECH809 Graduate Research Seminar A ······ (1-0-1)

MECH899 Doctoral Dissertation Research ······ (Credits can vary)

[Common Subjects]

GEDU501 Scientific Writing for Graduate Students ······ (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing. To this end, published papers are analyzed and their characteristics are identified. Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill ······ (3-0-2)

The course will focus on professional presentations for international conferences. Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers. The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics ······ (1-0-1)

- Research Ethics for responsible research of POSTECH graduate students
- Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ······ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ······ (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 scientific and 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 in engineering practice.

MECH526 Theory and Applications of Electromechanical Energy Conversion ······ (3-1-3)

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

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

MECH531 Acoustics ······ (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.

CHEB621 Advanced Thermodynamics ······ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

Department of Industrial and Management Engineering

1. Program Overview

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

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

- Operations Research and Supply Chain Management

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

- Product Life-cycle Engineering

Due to environmental concern, how the product is designed, used, and recycled becomes a key factor determining value of the product. PLE is researching state-of-the-art methodologies for sustainable product life-cycle engineering covering product and product-service design and development, manufacturing, use and recycling, and information acquisition and exchange infrastructure via ubiquitous technology. Major topics are:

1) Product life-cycle analysis and management,
2) Green product and product-service development (Eco-design),
3) Sustainable manufacturing,
4) Ubiquitous system engineering (USE) and product life-cycle information infrastructure (UPLII).

- Ergonomics and Human Computer Interaction

Ergonomics/HCI covers development of user-centered designs considering physical, physiological, cognitive, and affective aspects of human for better usability and customer values. Topics of the area include biomechanics, HCI, usability engineering, universal design, affective design, product design &

development. Recent research focuses especially on mobile phone user interface design & evaluation, physical UI for consumer electronic products, user experience, and universal design for housing facilities.

- Strategic Technology Management

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

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

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

- Data Mining and Business Intelligence

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

- Financial Engineering

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

- Service Science, Management and Engineering

Services science seeks to use expertise in industrial engineering and its related fields such as technology, management, mathematics and social science to improve the performance of service business. Our main research emphasis is placed on the engineering approach to new service development, service operation and management, service improvement and innovation, and customer value management. Special attention will be given to knowledge-intensive service industries with high impact, including healthcare service, information and communication service, financial service, and logistics service.

[Remarks on Graduation requirements with degrees in IME]

- All graduate students are required to take Graduate Seminar (IMEN801, IMEN802). However, foreign

students are not required to do so.
a. Master's Program students must take Graduate Seminar for two semesters.
b. Ph.D Program students must take Graduate Seminar for three semesters.
c. M.S-Ph.D Integrated Program students must take Graduate Se minor 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.

Programs	Course Credit	Research Credit	Overall Credit
M.S	24 Credits	4 Credits	28 Credits
Ph.D	18 Credits	14 Credits	32 Credits
Integrative	42 Credits	18 Credits	60 Credits

- The MSIE program requires the completion of at least 15 credits from 400-level or graduate courses offered by the Department of Industrial and Management Engineering.

- Research Ethics(ICEC501) : Mandatory for all graduate students.
It is recognized only as a graduation requirement and excluded from graduation credits.

2. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	-Excluded from graduation credits
			Free Elective	Research Paper Presentation Skill	
			Free Elective	Research Ethics	
			Major Elective	Current Trends in Chemistry	
			Major Elective	Electrochemistry for Energy Applications	
			Major Elective	Applied Numerical Methods	
			Major Elective	Transducer Theory & Its Applications	
			Major Elective	Acoustics	
			Major Elective	Advanced Thermodynacis	
			Major Elective	A Study on Interplays of Humanities and Technology	
			Major Elective	Convergence Imagination & Design Thinking of Engineering	
			Major Elective	Introduction to Environmental Engineering	
			Major Elective	Artificial Intelligence & Data Science	
Dept.	Required Courses		Major Requirement	Special Topics in Advanced Industrial Engineering	
			Major Requirement	IME Seminar I	
			Major Requirement	IME Seminar II	
	Core Electives (by Major)	Operations Research and Supply Chain Management/ Service Science	Major Elective	Game Theory and Business Applications	
			Major Elective	Advanced Linear Programming	
			Major Elective	Discrete Optimization	
			Major Elective	Applied Stochastic Processes	
			Major Elective	Nonlinear Programming	
			Major Elective	Dynamic Programming and Reinforcement Learning Applications	
			Major Elective	Queueing Theory	
			Major Elective	Service Quality Engineering	
		Product Lifecycle Engineering	Major Elective	Factory Automation & Control	
			Major Elective	Smart Manufacturing	
			Major Elective	Product Design and Development	
			Major Elective	Manufacturing Intelligence	
			Major Elective	Advanced Topics in Numerical Control	

Classification			Category	Course Title	Remarks
			Major Elective	Advanced Topics in Robotics	
		Ergonomics and Human Computer Interaction	Major Elective	Ergonomics Laboratory	
			Major Elective	Human Factors Research Mathodology	
			Major Elective	Human-Computer Interface	
		Strategic Technology Management	Major Elective	Product Development Strategy	
			Major Elective	Science and Technology Policy Research	
			Major Elective	Digital Management	
			Major Electiv	Technology Planning	
			Major Electiv	Advanced Management Information System	
			Major Electiv	Engineering System Design and Analysis	
Dept.	Core Electives (by Major)	Data Mining and Business Intelligence	Major Electiv	Process Mining	
			Major Electiv	Programming for data science	
			Major Electiv	Time Series Analysis	
			Major Electiv	Statistical methods with sparsity(Special Topics)	
			Major Electiv	Bayesian statistics for data analysis(Special Topics)	
			Major Electiv	Mathematics for Data Science((Special Topics)	
		Financial Engineering	Major Electiv	Financial Engineering	
			Major Electiv	Advanced Investment Theory	
			Major Electiv	Integrated Risk Management(Special Topics)	
			Major Electiv	Corporate valuation with case studies(Special Topics)	
		*Industrial Artificial Intelligence	It is a convergent program of the 7 research areas. Refer to Section 2. Department Curriculum Roadmap.		
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	

3. Departmental Curriculum Roadmap

Major	Category	Course Title
Operations Research and Supply Chain Management/ Service Science	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Game Theory and Business Applications, Advanced Linear Programming, Discrete Optimization, Applied Stochastic Processes, Nonlinear Programming, Dynamic Programming and Reinforcement Learning Applications, Queueing Theory, Service Quality Engineering
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Product Lifecycle Engineering	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Factory Automation & Control, Smart Manufacturing, Product Design and Development, Manufacturing Intelligence, Advanced Topics in Numerical Control, Advanced Topics in Robotics
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Major	Category	Course Title
Ergonomics and Human Computer Interaction	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Ergonomics Laboratory, Human Factors Research Mathodology, Human-Computer Interface
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Strategic Technology Management	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Product Development Strategy, Science and Technology Policy Research, Digital Management, Technology Planning, Advanced Management Information System, Engineering System Design and Analysis
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Data Mining and Business Intelligence	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Process Mining, Programming for data science, Time Series Analysis, Statistical methods with sparsity(Special Topics), Bayesian statistics for data analysis(Special Topics), Mathematics for Data Science((Special Topics)
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Financial Engineering	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Special Topics in Advanced Industrial Engineering, IME Seminar Ⅰ & Ⅱ
	Major Electives by major	Financial Engineering, Advanced Investment Theory, Integrated Risk Management(Special Topics), Corporate valuation with case studies(Special Topics)
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

Major	Category	Course Title
Industrial Artificial Intelligence	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics, Programming for data science, Smart Manufacturing, IME Seminar Ⅰ & Ⅱ
	Dept. Core Required Electives	Business Analytics(undergraduate), Statistical Data Mining(undergraduate), Advanced Linear Programming, Time Series Analysis, Engineering System Design and Analysis, Complex Systems(undergraduate), Applied Stochastic Processes, Applied Stochastic Processes, Process Mining
	Major Electives by major	Nonlinear Programming, Queueing Theory, Advanced Artificial Intelligence for M.E.(Mechanical Engineering), Applications of Mathematics and Big Data(Mathematics), Dynamic Programming and Reinforcement Learning Applications
	Interdisciplinary Electives	Product Development Strategy, Entrepreneuship Special Lecture(undergraduate), Special Topic in Industrial and Management Engineering: Steel Industry and Business Analytics, Introduction to Metallurgical Engineering (materials science and engineering)
	Industrial application technology: Industrial Technology	Manufacturing Intelligence, Service Quqlity Engineering, Manufacturing Information Technology, Human Performance, Financial Engineering, Scheduling System, Network Flows, Human-Computer Interface, Game Theory and Business Applications

4. 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 Factory Automation & 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 Smart Manufacturing ···· (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 wangling, 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.

IMEN583 Process Mining ························· (3-0-3)

Process mining bridges the gap between traditional model-based process analysis (e. g. simulation and other business process management techniques) and data-centric analysis techniques such as machine learning and data mining. The course explains the fundamental analysis techniques in process mining such as process discovery algorithms, process simulation, social network discovery, conformance checking, etc. Moreover, the course will provide easy-to-use software, real-life data sets, and practical skills to apply the theory in various application domains.

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 Degital 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 Mathodology ······ **(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, ractional 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, Erogonomics 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 Engineerin ························ (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-ti me 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)

GEDU501 Scientific Writing for Graduate Students······ (3-0-2)

GEDU502 Research paper Presentation Skill······ (3-0-2)

ICEC501 Research Ethics······ (1-0-1)

Department of Electrical Engineering

1. Learning Goal

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

2. Program Overview

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

- Control and Power

In the modern society, control and optimal operation of complicated systems have recently become important to maintain and further enhance their efficiency and performance. In the Department of Electrical Engineering, we are making great efforts and continuous progresses in developing innovative automatic control technologies and establishing world-renowned research and education programs. The main areas of ongoing research include nonlinear control, robust control, intelligent control, adaptive control, and optimal control. In application areas, our control research is also closely relevant to renewable and distributed generator control, power network control and state estimation, electrical and thermal load control, AC/DC motor drive and power conversion, robotics, process control, unmanned vehicle control, and fault detection and prediction.

- 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. Recently studies in the fields also include machine learning-based optimization/information theory and network systems for massive drones and robots.

- 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.

- Electromagnetics and Microwave Engineering

Designated as one of the fast growing fields, applied electromagnetics and micowave engineering are instrumental across a variety of wireless applications. This is becoming increasingly evident amid the advent of 5G, 6G wireless communication. Moreover, the proliferation of microwave radars, radio astronomy, remote sensing, microwave circuits and modeling and novel microwave processing continues to expand the breadth and depth of this field.

Specific research topics include device modeling using at super high frequency, intelligent antennas and phased array antenna systems, 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 11 laboratories for researching semiconductor theory, materials, devices, displays, sensors, quantum computing, and systems.

The main research areas are 3D Flexible Sensor, device and Circuit, Smart Display & Device with Soft Electronics, Nano Bio TeraHz Photonics, Advanced Nanoscale device and their Applications, Nano Devices and Processing, Exploratory Electronic System Lab, Physical Electronics Lab, Wave Array and Display Engineering, Advance devices and Circuit, Quantum computing and quantum network, and Intelligent Semiconductor and Wearable Device.

- 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, as well as electronic design automation for integrated circuits.

In this field, the ongoing research includes high-speed CMOS interface circuits such as Gbps DRAM interface 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 new design automation techniques adopting artificial intelligence and various software techniques.

[Credits Required for Graduation]

- Until 2020 students enrolled

Programs	Course Credit	Research Credit	Overall Credit
Master's Program	24 Credits	4 Credits	28 Credits
Doctoral Program	18 Credits	14 Credits	32 Credits
MS/PhD Integrated Program	36 Credits	24 Credits	60 Credits

- Starting in 2021

Programs	Course Credit	Research Credit	Overall Credit	Remarks
Master's Program	24(3) Credits	4 Credits	28 Credits	Each major group must have 3 credits
Doctoral Program	18 Credits	14 Credits	32 Credits	-
MS/PhD Integrated Program	36(3) Credits	24 Credits	60 Credits	Each major group must have 3 credits

[Required to all students]

1) A must-have graduate school (Master's & MS/PhD Integration Program) course.

- To strengthen convergence education in the graduate school of electronic and electrical engineering, Mandatory courses for artificial intelligence subjects are designated as mandatory.
- Depending on your major group, designating one of the AI basic/core subject groups, Completion of a major is mandatory.
- Depending on the field of the advisor and the group he belongs to, Since the group of supervised students is the same, Register for classes after checking the group to which the supervisor belongs.
- Mandatory courses for each major group may differ, Information according to the enrollment period for each semester.

2) Undergraduate course credits

Division	Until 2018 students enrolled	Starting in 2019
Undergraduate Courses (Maximum 6 credits)	400units (G or S/U)	200 ~ 400units (G or S/U)

3) 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).

4) Guide for attending GEDU501/502

- Scientific Writing **for Graduate Students**(GEDU501) : Mandatory for all graduate students.
- Research Paper Presentation Skill (GEDU 502) : Mandatory for Ph.D. Program students and MS/PhD Integrated Program.

※ Graduate students of electrical engineering are required to take these two courses.
However, they are only recognized as graduation requirement and excluded from graduation credits

※ In the case of advancing from Master's to Doctoral program students, the mandatory English courses taken during the master's course can be recognized.

5) Guide for attending ICEC501 (Starting in 2023)

- **Research Ethics**(ICEC501) : Mandatory for all graduate students.

※ Graduate students of electrical engineering are required to take these two subjects.
It is recognized only as a graduation requirement and excluded from graduation credits

※ In the case of advancing from Master's to Doctoral program students, Compulsory Research Ethics courses taken during the master's course can be recognized.

3. Course Table

Area	Course No	Title	lec-lab.-cr.
Common Subjects	EECE695A/Z	Advanced Topics in Electrical Eng.A/Z	1~3
	GEDU501	Scientific Writing for Graduate Students	3-0-2
	GEDU502	Research Paper Presentation Skill	3-0-2
	ICEC501	Research Ethics	1-0-1
Control & Power Electronic	EECE564	Linear System Theory	3-0-3
	EECE565	Robotics	3-0-3
	EECE567	Power Electronics Systems	3-0-3
	EECE568	Optimal Control Theory	3-0-3
	EECE659	Nonlinear System Theory	3-0-3
	EECE660	Motor Control Theory	3-0-3
	EECE663	Estimation Theory	3-0-3
	EECE668	Robust Control	3-0-3
	EECE672	Linear Optimal Control	3-0-3
	EECE753	Special Topics in Control System A/Z	3-0-3
Communication & Signal processing	EECE573	Space-Time Communications and Signal Processing	3-0-3
	EECE574	Probability and Random Process	3-0-3
	EECE575	Communication and Sensing Systems	3-0-3
	EECE576	Statistical Communication Theory	3-0-3
	EECE577	Information Theory	3-0-3
	EECE578	Digital Communication	3-0-3
	EECE579	Information and Communication Security	3-0-3
	EECE580	Spread-Spectrum Communications and Global Positioning System	3-0-3
	EECE581	Digital Signal Processing	3-0-3
	EECE582	Error-correcting Codes	3-0-3
	EECE583	Advanced Linear Algebra	3-0-3
	EECE589	Modern Coding Theory	3-0-3
	EECE645	Statistical Signal Processing	3-0-3
	EECE670	Signal Design	3-0-3
	EECE677	Cryptographic Algorithms	3-0-3
	EECE754A/Z	Special Topics in Communication and Signal Processing A/Z	3-0-3

Area	Course No	Title	lec-lab.-cr.
Computer	EECE550	Advanced Computer Design	3-0-3
	EECE551	Digital Image Processing	3-0-3
	EECE552	Computer Vision	3-0-3
	EECE553	Introduction to Neural Networks	3-0-3
	EECE594	Recognition Engineering	3-0-3
	EECE651	Computational Intelligence	3-0-3
	EECE750A/Z	Special Topics in Computer Engineering A/Z	3-0-3
	EECE751	Speech Recognition and Synthesis	3-0-3
Electromagnetic Field & Super High Frequency	EECE584	Advanced Electromagnetics I	3-0-3
	EECE585	Radar System Engineering I	3-0-3
	EECE586	Numerical Techniques in Electromagnetics	3-0-3
	EECE587	Microwave Engineering	3-0-3
	EECE588	Antenna Theory and Design I	3-0-3
	EECE671	Advanced Electromagnetics II	3-0-3
	EECE753A/Z	Special Topic in Electromagnetics A/Z	3-0-3
Semiconductor & Quantum Electronics	EECE555	Properties of Optical Materials and Devices	3-0-3
	EECE556	Advanced Logic Semiconductor Device	3-0-3
	EECE557	Advanced Nanoscale Fabrication and Manufacturing	3-0-3
	EECE559	Principles of Biomedical Opt. & Imaging	3-0-3
	EECE562	Applied Quantum Mechanics I	3-0-3
	EECE563	Quantum Mechanics for Applied Nanotechnology	3-0-3
	EECE591	Medical Device Design Process	3-0-3
	EECE592	Semiconductor Transport Theory	3-0-3
	EECE593	Microwave Active Circuit	3-0-3
	EECE596	RFIC design	3-0-3
	EECE598	Nanoscale Devices	3-0-3
	EECE637	Physics & Characterization of Next-generation Devices	3-0-3
	EECE638	Advanced Digital Integrated Circuit Design	3-0-3
	EECE639	Printed Organic Thin Film Transistor	3-0-3
	EECE642	Advanced MOS Devices	3-0-3
	EECE653	Semiconductor Fabrication Processing	3-0-3
	EECE655	Quantum Electronics	3-0-3
	EECE676	Guided Wave and Integrated Optics	3-0-3
	EECE752A/Z	Special Topics in Solids and Quanta A/Z	3-0-3
VLSI	EECE569	Analog Integrated Circuits	3-0-3
	EECE570	Digital Integrated Circuits	3-0-3
	EECE571	VLSI System Design	3-0-3
	EECE597	Link Circuit Design	3-0-3
	EECE667	VLSI analysis and design software	3-0-3
	EECE669	VLSI Signal Processing	3-0-3
	EECE680	Data Converters	3-0-3
Research	EECE595	Seminars in Electrical Engineering	1-0-1
	EECE699(1-9)	Master Thesis Research	1~9
	EECE899(1-9)	Doctoral Dissertation Research	1~9
	ENTP451A	Emerging Industry A: Technology Startup	1-0-1
	ENTP451B	Emerging Industry B: Service Startup	1-0-1
	CITE215 (ENTP461)	Intro. to Makers	2-0-2
	INTN800	Internship Program	1-4
	INTN801	Start-up Practice(TS)	가변학점

4. Major Field Courses Listed by Category

Classification		Category	Course Title	Remarks
Univ.	Common Subjects	Free Elective	Scientific Writing for Graduate Students	*Required courses for graduation. *Excluding graduation credits
			Research paper Presentation Skill	
			Research Ethics	*Required courses for graduation. *Excluding graduation credits *Applicable starting from the 2023 incoming class.
		Major Elective	Current Trends in Chemistry	
			Electrochem. for Energy Applications	
			Applied Numerical Methods	
			Transducer Theory & its Applications	
			Acoustics	
			Adv. Thermodynamics	
			A Study on Interplays of Human & Tech.	
			Conv. Imagination & Deshign Thinking of Eng.	
			Intro. to Environmental Eng.	
			Artificial Intelligence & Data Science	

Classification				Category	Course Title	Remarks
Dept.	Common Subjects			Research Subjects	Seminars in Electrical Engineering	
					Master Thesis Research	
					Doctoral Dissertation Research	
					Emerging Industry A: Technology Startup	
					Emerging Industry B: Service Startup	
					Emerging Industry C: Intro. to Makers	
					Intro. to Makers	
					Internship Program	
					Start-up Practice (TS)	
				Major Elective	Advanced Topics in Electrical Eng. A/Z	
	AI System	Core Required Elective (Choice 1)		Major Requirement	Computational Intelligence	
		Core Elective (by Major)	Control and Power	Major Elective	Linear System Theory	
					Robotics	
					Power Electronics Systems	
					Optimal Control Theory	
					Nonlinear System Theory	
					Motor Control Theory	
					Estimation Theory	
					Robust Control	
					Linear Optimal Control	
					Special Topics in System Theory A/Z	
			Communications and Signal Processing	Major Elective	Space-Time Communications and Signal Processing	
					Probability and Random Process	
					Communication and Sensing Systems	
					Statistical Communication Theory	
					Information Theory	
					Digital Communication	
					Information and Communication Security	
					Spread-Spectrum Communications and Global Positioning System	
					Digital Signal Processing	
					Error-correcting Codes	
					Advanced Linear Algebra	
					Modern Coding Theory	
					Statistical Signal Processing	
					Signal Design	
					Cryptographic Algorithms	
					Special Topics in Communication and Signal Processing A/Z	
			Computer	Major Elective	Advanced Computer Design	
					Digital Image Processing	
					Computer Vision	
					Introduction to Neural Networks	
					Recognition Engineering	
					Special Topics in Computer Engineering A/Z	
					Speech Recognition and Synthesis	

Classification				Category	Course Title	Remarks
Dept	AI Device	Core Required Elective (Choice 1)		Major Requirement	Introduction to Machine Learning System	Undergraduate Courses
		Core Elective (by Major)	Electromagnetic Field & Super High Frequency	Major Elective	Advanced Electromagnetics I	
					Radar System Engineering I	
					Numerical Techniques in Electromagnetics	
					Microwave Engineering	
					Antenna Theory and Design I	
					Advanced Electromagnetics II	
					Special Topic in Electromagnetics A/Z	
			Semiconductor & Quantum Electronics	Major Elective	Properties of Optical Materials and Devices	
					Advanced Logic Semiconductor Device	
					Advanced Nanoscale Fabrication and Manufacturing	
					Principles of Biomedical Opt. & Imaging	
					Applied Quantum Mechanics I	
					Quantum Mechanics for Applied Nanotechnology	
					Medical Device Design Process	
					Semiconductor Transport Theory	
					Microwave Active Circuit	
					RFIC design	
					Nanoscale Devices	
					Physics & Characterization of Next-generation Devices	
					Advanced Digital Integrated Circuit Design	
					Printed Organic Thin Film Transistor	
					Advanced MOS Devices	
					Semiconductor Fabrication Processing	
					Quantum Electronics	
					Guided Wave and Integrated Optics	
					Special Topics in Solids and Quanta A/Z	
			VLSI	Major Elective	Analog Integrated Circuits	
					Digital Integrated Circuits	
					VLSI System Design	
					Link Circuit Design	
					VLSI analysis and design software	
					VLSI Signal Processing	
					Data Converters	
	Interdisciplinary Electives			Major Elective	Undergraduate Courses 200 ~ 400units (G or S/U)	Undergraduate Courses (Maximum 6 credits)
					Graduate course in another department	Must be guided by a Adviser

※ Core required elective courses are currently being offered as special topics courses, and they are expected to be expanded upon conversion to regular courses in the future, depending on applications for conversion.

4. Departmental Curriculum Roadmap

Group	Major	Category	Course Title
AI System	Control & Power Electronic	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill, Research Ethics
		Dept. Core Required Electives	Computational Intelligence
		Major Elective by major	Linear System Theory, Robotics Power Electronics Systems, Optimal Control Theory, Nonlinear System Theory, Motor Control Theory, Estimation Theory, Robust Control, Linear Optimal Control, Special Topics in System Theory A/Z, Advanced Topics in Electrical Eng. A/Z
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department
	Communication & Signal processing	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill. Research Ethics
		Dept. Core Required Electives	Computational Intelligence
		Major Elective by major	Space-Time Communications and Signal Processing, **Probability and Random Process**, Communication and Sensing Systems, Statistical Communication Theory, Information Theory, **Digital Communication, Information and Communication Security**, Spread-Spectrum Communications and Global Positioning System, **Digital Signal Processing, Error-correcting Codes, Advanced Linear Algebra, Modern Coding Theory, Statistical Signal Processing, Signal Design, Cryptographic Algorithms, Special Topics in Communication and Signal Processing A/Z, Advanced Topics in Electrical Eng. A/Z**
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department
	Computer	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill. Research Ethics
		Dept. Core Required Electives	Computational Intelligence
		Major Elective by major	Advanced Computer Design, Digital Image Processing, Computer Vision, Introduction to Neural Networks, Recognition Engineering, Speech Recognition and Synthesis, Special Topics in Computer Engineering A/Z, Advanced Topics in Electrical Eng. A/Z
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department
AI Device	Electromagnetic Field & Super High Frequency	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill. Research Ethics
		Dept. Core Required Electives	Introduction to Machine Learning System
		Major Elective by major	Advanced Electromagnetics Ⅰ, Radar System Engineering Ⅰ, Numerical Techniques in Electromagnetics, Microwave Engineering, Antenna Theory and Design Ⅰ, Advanced Electromagnetics Ⅱ, Special Topic in Electromagnetics A/Z, Advanced Topics in Electrical Eng. A/Z
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department
	Semiconductor & Quantum Electronics	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill. Research Ethics
		Dept. Core Required Electives	Introduction to Machine Learning System
		Major Elective by major	Properties of Optical Materials and Devices, Advanced Logic Semiconductor Device, Advanced Nanoscale Fabrication and Manufacturing, Principles of Biomedical Opt. & Imaging, Applied Quantum Mechanics Ⅰ, Quantum Mechanics for Applied Nanotechnology, Medical Device Design Process, Semiconductor Transport Theory , Microwave Active Circuit, REIC design, Nanoscale Devices, Physics & Characterization of Next-generation Devices, Advanced Digital Integrated Circuit Design, Printed Organic Thin Film Transistor, Advanced MOS Devices, Semiconductor Fabrication Processing, Quantum Electronics, Guided Wave and Integrated Optics Special Topics in Solids and Quanta A/Z, Advanced Topics in Electrical Eng. A/Z
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department
	VLSI	Common Subjects	Scientific Writing for Graduate Students, Research paper Presentation Skill, Research Ethics
		Dept. Core Required Electives	Introduction to Machine Learning System
		Major Elective by major	Analog Integrated Circuits, Digital Integrated Circuits, VLSI System Design, Link Circuit Design, VLSI analysis and design software, VLSI Signal Processing, Data Converters, Advanced Topics in Electrical Eng. A/Z
		Interdisciplinary Electives	Undergraduate Courses 200 ~ 400units, Graduate course in another department

5. Course Description

GEDU501 Scientific Writing for Graduate Students····· (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 hilp in this process. There will be no formal examinations; all marks will be based on exercises, assignments, and the final manuscript.

GEDU502 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.

ICEC501 Research Ethics····· (1-0-1)

Research Ethics for responsible research of POSTECH graduate students Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

EECE550 Advanced Computer Design····· (3-0-3)

Prerequisites: Computer Design

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

EECE551 Digital Image Processing····· (3-0-3)

Prerequisites: Digital Signal Processing

The purpose of this course is to introduce some basic image enhancement, restoration, segmentation, edge detection, compression, transformation and properties of human visual system along with their recent application areas.

EECE552 Computer Vision····· (3-0-3)

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

EECE553 Introduction to Neural Networks····· (3-0-3)

Prerequisites: 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.

EECE555 Properties of Optical Materials and Devices ········· (3-0-3)

Electronic energy band structure, perturbation theory, effective mass theory, k·p theory, optical gain and absorption in bulk and nano-structures, semiconductor lasers, high speed modulation.

EECE557 Advanced Nanoscale Fabrication and Manufacturing ········· (3-0-3)

Prerequisite: Intro.to Nanoscale Science & Engineering

Nanoscale science and engineering involve refining the functional properties of materials, devices, or systems with at least one dimension in the 1-100 nm range. Recent advancements in nanoscience have revolutionized multiple fields, driving innovations in healthcare, energy, computing, and communications. This course explores cutting-edge technologies influenced by breakthroughs in nanoscale research, including nanoelectronics, nanooptics, nanophotonics, nanomagnetics, nanomechanical systems, and nanosensors. A key focus is on understanding the theory, design, fabrication, characterization, and application of various nanomaterials and nanostructures. The course also covers state-of-the-art nanofabrication techniques, including advanced lithography, atomic layer deposition (ALD), self-assembly methods, and emerging hybrid approaches that integrate top-down and bottom-up fabrication strategies. Furthermore, students will explore various applications enabled by nanoscale fabrication, such as high-performance optical components, next-generation semiconductor devices, advanced sensors, and bio-integrated nanotechnology. Through this, students will gain a comprehensive understanding of how nanofabrication techniques contribute to real-world technological advancements.

EECE556 Advanced Logic Semiconductor Device ········· (3-0-3)

The course focuses on semiconductor materials, processes, and device technologies to provide an in-depth understanding of Si-based logic semiconductor devices from the 90nm node to sub-3nm nodes (More Moore), as well as exploring novel concepts (Beyond Moore) in logic semiconductor devices.

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.

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.

EEСE563 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 majoring in engineering with the background of nanotechnology and the basic knowledge of quantum mechanics for nano devices and their applications, especially on semiconductor devices.

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.

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.

EECE573 Space-Time Communications and Signal Processing ······ **(3-0-3)**

In this course, the propagation characteristics and channel models are studied for communication and sensing systems using multiple antennas.

It is also studied how to estimate the 3-D channel parameters and how to process the received signal. The channel capacity of the space-time communication channel is studied and a variety of multiple-input multiple-output modulation/demodulation methods are studied for achieving the capacity.

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 and Sensing Systems ······ **(3-0-3)**

This course covers how to mathematically model and analyze the components of digital communication and sensing systems such as a baseband modem, a DAC, an I/Q modulator, an upconversion mixer, an RF chain, a power amplifier, an antenna, a pre-select filter, a low-noise amplifier, an image reject filter, a down-conversion mixer, a channel-select filter, an ADC, an I/Q demodulator. It also covers the structure and difference between a digital baseband and digital IF receivers. Digital modulation schemes and their power spectra are studied.

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 Theory ······ **(3-0-3)**

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)**

This course covers a variety of wired and wireless communication systems, terrestrial and non-terrestrial communication systems, wireless standards and their radio transmission technologies, and network structure and functions.

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 and Global Positioning System ······ **(3-0-3)**

This course covers spread-spectrum techniques used in communications and the Global Positioning System. The students will study the following topics: 1) principles of the spread-spectrum systems, 2) the basic principles of Pseudo-Noise (PN) sequence, 3) the basic concepts of direct-sequence (DS) and frequency-hopping (FH) spread-spectrum systems, 4) performance analysis of spread-spectrum communications under multiple-access or jamming environments, 6) how the spread-spectrum techniques are applied to the GPS.

EECE581 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 plne 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.

EECE591 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.

EECE592 Semiconductor Transport Theory ······ (3-0-3)

The class discusses carrier transport in semiconductors for graduate and senior undergraduate students. The course will review the essential parts of quantum mechanics, statistical physics, and solid-state physics at the beginning to understand the energy band structure of crystals and how to calculate them. Analyzing the real band structure of crystals, students will learn the crucial concepts for carrier transport, including effective mass, density of states, etc. The class will continue to discuss the Boltzmann transport model and the concept of phonons, ionized impurities, and scattering by them. Finally, the non-equilibrium Green function approach under Keldysh formalism will be discussed for non-equilibrium quantum mechanical transport.

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.

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.

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.

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.

EECE642 Advanced MOS Devices ··· (3-0-3)

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 ··· (3-0-3)

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.

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.

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.

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.

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 VLSI Signal Processing ··· **(3-0-3)**

This course covers the following VLSI signal processing concepts: Iteration bound, pipelining and parallel processing, retiming and unfolding technique, folding technique, systolic array designs and fast convolution, algorithm strength reduction. Additionally, to foster a broad understanding of computer arithmetic, the following concepts are also addressed: Conventional and unconventional number systems, fast addition/subtraction, binary floating-point number system, sequential algorithms for multiplication and division, high-speed multiplication, fast division, division through multiplication. Students will engage in individual research projects focusing on signal processing algorithm optimization based on concepts learned in the course, providing hands-on design experience where theoretical principles are applied to real-world problems.

EECE670 Signal Design ········ **(3-0-3)**

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.

EECE671 Advanced Electromagnetics Ⅱ ········ **(3-0-3)**

Prerequisite: EECE584(Advanced Electromagnetics Ⅰ)

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

EECE672 Linear Optimal Control ········ **(3-0-3)**

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.

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 srystal 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.

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/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 Processign, 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 processign 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.

EECE899 Doctoral Dissertation Research ························ (1-9)

A research course for Ph. D. thesis.

[Common Subjects]

GEDU501 Scientific Writing for Graduate Students ························ (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified. Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill ························ (3-0-2)

The course will focus on professional presentations for international conferences. Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers. The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics ······································ (1-0-1)

- Research Ethics for responsible research of POSTECH graduate students
- Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ······································ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ······································ (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 scientific and 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 in engineering practice.

MECH526 Transducer Theory and Its Applications ······································ (3-1-3)

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

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

MECH531 Acoustics ······································ (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.

CHEB621 Advanced Thermodynamics ································ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

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.

[Computing Systems]
Computing Systems aims to develop and operate various optimal computer systems with consideration of performance, cost, and reliability, from the device level to a large scale computing environment. It is a fundamental field that props up the computer-based IT industry. At the core of its importance lies in-depth knowledge in theory and practice of hardware and software in a large scope.

[Network Systems]
Network Systems is an essential field in the modern computer industry in which information is disseminated by many connected computers. Not only that, its increasing role as an infrastructure that supports various fields including BT and NT is ever more important.

[Computer Security]
Computing Security aims to develop techniques for protecting computer systems and networks from the theft or damage to the software and hardware. Its importance is rapidly growing as reliance on computer systems is increasing. The department at POSTECH covers systems security, software security, mobile security, and IoT security.

[Human-Computer Interaction]
HCI studies everything related to two-way communication between users and computers, based on the fact that it is human beings who use computers. It is one of the most exemplary interdisciplinary fields combining computer engineering-based technology with humanitarian studies, which has its

basis in psychology, sociology, etc.

[Natural Language Processing]
Natural Language Processing (NLP) is a field that studies technologies enabling computers to understand and generate human language. It aims to analyze and interpret the structure and meaning of textual and spoken data, encompassing various applications such as machine translation, question-answering systems, sentiment analysis, text summarization, and conversational AI. With recent advancements in deep learning and large-scale language models, NLP has become increasingly sophisticated and powerful, driving innovations in human-computer interaction and transforming the way we communicate with artificial intelligence.

[Software Engineering & Programming Languages]
Software Engineering & Programming Languages aims to develop programming languages and software that provide theoretical backgrounds and facilitate communication between the computer and human beings, which are indispensable to computing theory, logic, language theory within the computing environment.

[Visual Computing]
Visual Computing aims to recognize, search, analyze, process, and represent images and videos. It covers a wide variety of subfields including Computer Graphics and Computer Vision. Computer Graphics aims to develop algorithms and techniques that can help create images and videos, and Computer Vision aims to develop algorithms for analyzing images and videos.

[Data Science]
Data Science aims to recognize, search, analyze, process, and represent data and deliver them effectively to users. Data science has critical importance in today's IT world where a massive amount of data is generated from a wide variety of sources in many different ways.

[Machine Learning]
Machine Learning aims to develop algorithms that improve automatically through experience. It is a rapidly growing field, which has numerous applications, due to the availability of large datasets and the growth of computing power. The department at POSTECH focuses on both theoretical and practical aspects of machine learning.

[Theory of Computing]
Theory of Computation aims to understand the nature of computation and analyze fundamental computational problems arising in other fields in Computer Science using mathematical tools. It covers a wide variety of topics including algorithms, data structures, and computational complexity.

[Credits Required for Degree]

Programs	Course Credit	Research Credit	Overall Credit
M.S.	18	10	28
Ph.D	15	17	32
Ms-Ph.D Integrated	30	30	60

[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)
   1) CSE school curriculum
   2) Graduate courses from other departments at POSTECH (as per the Department's internal rules); for master's program up to 9credits, for doctoral program up to 7credits, for MS/PhD Integrated Program up to 15credits can possibly be counted as course credits.
      In such a case, their evaluations for the courses must be given by letter grades.
   3) 300, 400-level undergraduate courses from CSE departments at POSTECH (up to 6credits to be counted toward a graduate degree. In such a case, their evaluations for the courses must be given by letter grades

2. Guide for Graduate Research Seminar CSED800A, 800B
   1) Both Master's and PhD program students must complete CSED800 at least twice to fulfill the major requirements.
   2) Integrated program students must complete CSED800 at least four times to fulfill the major requirements.

3. Guide for GEDU501, 502
   1) Scientific Writing for Graduate Students (GEDU501) is mandatory for all graduate students.
   2) Research Paper Presentation Skill (GEDU 502) is mandatory for Ph.D. Program students and MS/PhD Integrated Program.
   ※ Graduate students of computer science are required to take these two subjects.
   - It is recognized only as a graduation requirement and does not count towards the graduation credits.
   - If students in the Master's program are planning to pursue the doctoral program upon graduation, it is not required for them to repeat Scientific Writing (GEDU501) and only the completion of Research Paper Presentation Skill (GEDU502) is required.

4. Guide for ICEC501
   1) Research Ethics (ICEC501) is mandatory for all graduate students.
   2) After and including the 2023 academic year number: Must take courses and it is not included in the graduation credits.
   ※ In the case of advancing from Master's to Doctoral program students, Research Ethics taken during the master's course can be recognized.

3. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	Computing Systems	Major Elective	Implementation and acceleration for machine learning	
			Major Elective	Deep Learning	
			Major Elective	Advanced Computer Architecture	
			Major Elective	Advanced Operating System	
			Major Elective	Digital Logic Testing	
			Major Elective	Real-time Systems	
			Major Elective	Parallel Processing	
		Network Systems	Major Elective	Transformation Theory	
			Major Elective	Network Performance Analysis	
			Major Elective	Distributed Processing	
			Major Elective	Network Management Systems	
			Major Elective	Advanced Computer Networks	
			Major Elective	Applications of Random Variable and Process in Computer Engineering	
			Major Elective	Mobile Networks	
			Major Elective	Multimedia Networking	
		Computer Security	Major Elective	Dependable Computing	
		Human-Computer Interaction·Natural Language Processing	Major Elective	Introduction to Virtual Reality	
			Major Elective	Introduction to Haptics	
			Major Elective	Advanced topics in Virtual Reality	
			Major Elective	Advanced Haptics	
			Major Elective	Introduction to Human-Computer Interaction	
		Natural Language Processing	Major Elective	Linguistics Basis for Natural Language Processing	
			Major Elective	Statistical Natural Language Processing	
			Major Elective	Deep Learning NLP	
			Major Elective	Machine Translation	
			Major Elective	Human Language Technology	
		Software Engineering & Programming Languages	Major Elective	Software Engineering	
			Major Elective	Parallel Algorithm	
			Major Elective	Formal Specification Techniques	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	Visual Computing	Major Elective	Computer Animation	
			Major Elective	Fuzzy and Intelligent Systems	
			Major Elective	3D Model Reconstruction	
			Major Elective	Computer Vision	
			Major Elective	Computational Photography	
			Major Elective	Simulation	
			Major Elective	Computational Imaging	
			Major Elective	Vision and Language	
		Data Science	Major Elective	Data Mining	
			Major Elective	Applications of Mathematics and Big Data	
			Major Elective	Artificial Intelligence & Data Science	
			Major Elective	Big Data Processing	
			Major Elective	Information Retrieval	
			Major Elective	Advanced Database	
		Machine Learning	Major Elective	Pattern Recognition	
			Major Elective	Implementation and acceleration for machine learning	
			Major Elective	Machine Learning	
			Major Elective	Probabilistic Graphical Models	
			Major Elective	Optimization for Machine Learning	
			Major Elective	Deep Learning	
			Major Elective	Reinforcement Learning	
			Major Elective	Trustworthy Machine Learning	
		Theory of Computing	Major Elective	Discrete and Computational Geometry	
			Major Elective	Advanced Algorithms	
	Core Electives	Common Subjects	Major Elective	Advanced Linear Algebra for CSE	
			Major Elective	Advanced Probability Theory for CSE	
			Major Elective	Topics in Computer Science A-Z	
			Major Elective	Topics in Computation Theory A-Z	
			Major Elective	Topics in Computer Systems A-Z	
			Major Elective	Topics in Artificial Intelligence A-Z	

Classification			Category	Course Title	Remarks
Dept.	Core Electives	Common Subjects	Research	Computer Science Seminar	
			Research	Master Thesis Research	
			Research	Doctoral Dissertation Research	
	Interdisciplinary Electives		Major Elective	300, 400-level undergraduate courses	Letter grad, up to 6credits
				Graduate courses from other departments	Letter grad, Master's program up to 9credits, Doctoral program up to 7credits, MS/PhD Integrated Program up to 15credits are allowed
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	S/U evaluation These credits are not included in the total credits
			Free Elective	Research paper Presentation Skill	
			Free Elective	Research Ethics	
			Major Elective	Current Trends in Chemistry	Another Department Subjects (500-level to 800-level graduate courses, excluding seminar courses), If the student wishes to have the credit acknowledged, choose to be evaluated on a letter grade basis.
			Major Elective	Electochem for Energy Applications	
			Major Elective	Applied Numerical Methods	
			Major Elective	Transducer Theory & Its Applications	
			Major Elective	Acoustics	
			Major Elective	Advanced Thermodynacis	
			Major Elective	A Study on Interplays of Humanities and Technology	
			Major Elective	Convergence Imagination & Design Thinking of Engineering	
			Major Elective	Introduction to Environmental Engineering	
			Major Elective	Artificial Intelligence & Data Science	

4. Departmental Curriculum Roadmap

Major	Category	Course Title
Computing Systems	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Implementation and acceleration for machine learning, Deep Learning, Advanced Computer Architecture, Advanced Operating System, Digital Logic Testing, Real-time Systems, Parallel Processing
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Network Systems	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Transformation Theory, Network Performance Analysis, Distributed Processing, Network Management Systems, Advanced Computer Networks, Applications of Random Variable and Process in Computer Engineering, Mobile Networks, Multimedia Networking
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Computer	Dept. Common Course	Advanced Linear Algebra for CSE

Major	Category	Course Title
Security		Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Dependable Computing
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Human-Computer Interaction	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Introduction to Virtual Reality, Introduction to Haptics, Advanced topics in Virtual Reality, Advanced Haptics, Introduction to Human-Computer Interaction,
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Natural Language Processing	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Linguistics Basis for Natural Language Processing, Statistical Natural Language Processing, Deep Learning NLP, Machine Translation, Human Language Technology
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Software Engineering & Programming Languages	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Software Engineering, Parallel Algorithm, Formal Specification Techniques
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Visual Computing	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Computer Animation, Fuzzy and Intelligent Systems, 3D Model Reconstruction, Computer Vision, Computational Photography, Simulation, Computational Imaging, Vision and Language
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Data Science	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Data Mining, Applications of Mathematics and Big Data, Artificial Intelligence & Data Science, Big Data Processing, Information Retrieval, Advanced Database
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Machine Learning	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Pattern Recognition, Implementation and acceleration for machine learning, Machine Learning, Probabilistic Graphical Models, Optimization for Machine Learning, Deep Learning, Reinforcement Learning, Trustworthy Machine Learning
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Theory of Computing	Dept. Common Course	Advanced Linear Algebra for CSE Advanced Probability Theory for CSE, Topics in Computer Science
	Major Electives by major	Theory of Computation, Discrete and Computational Geometry, Advanced Algorithms
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Univ.	Common Course	Scientific Writing for Graduate Students Research paper Presentation Skill, Research Ethics
		Current Trends in Chemistry, Electochem for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Advanced Thermodynacis, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & Data Science

5. 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, Positive Definite Matrices, etc.

CSED501 Transformation Theory ······ **(3-0-3)**

In this class, we study transforms that are widely used in the variety of engineering areas. At first, the general concept of transform is introduced, and then especially we focus on sinusoidal linear transforms. In the continuous time domain, Fourier Series and Fourier Transform are introduced for the periodic functions and the aperiodic functions, respectively. Next we derive Laplace Transform by expanding the concept of Fourier Transform. In the discrete time domain, we study Sampling Theorem, DTFT(Discrete Time Fourier Transform), DFT(Discrete Fourier Transform), and z-transform in detail. In addition, we study the relations among the above sinusoidal linear transforms. Finally, we discuss how to apply these transformations to a variety of applications in computer science and engineering.

CSED502 Theory of Computation ······ **(3-0-3)**

Recommended Prerequisites : CSED341 (Automata and Formal Languages)

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

CSED503 Advanced Computer Architecture ······ **(3-0-3)**

Recommended Prerequisites : CSED311 (Computer Architecture)

This course is a study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of high-performance computer systems. The emphasis is on the major component subsystems of high performance computers: pipelining, instruction level parallelism, memory hierarchies, input/output, and network-oriented interconnections. Topics may include: instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order 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.

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.

CSED510 Implementation and acceleration for machine learning ···························· (3-0-3)

Recommended Prerequisites : CSED342 (Artificial Intelligence), CSED311 (Computer Architecture)

Deep learning applications are actively used in various types of applications. The amount of computation required for inference and training is increasing rapidly, and at the same time, the demand for deploying these applications on mobile devices is also increasing. Deep learning optimization is becoming more and more important. In this course, we will learn advanced optimization techniques from the perspective of both hardware and software. By learning various studies about how to optimize deep learning algorithms, we could acquire knowledge that will be helpful in future research.

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 Statistcs)

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 3D Model Reconstruction ································· (3-0-3)

Modeling is a key component of 3D graphics applications. This course covers various issues and approaches of 3D model reconstruction. We first discuss the basic ideas, representative methods, and potential applications of 3D geometry reconstruction. We then consider geometry processing methods useful for enhancing the reconstructed geometry. We also discuss color and material reconstructions needed for realistic rendering of reconstructed models. Finally we cover important and popular application areas of 3D model reconstruction.

CSED520 Computational Imaging ························· (3-0-3)

Computational imaging has fueled the rapid developments of many application systems, including mobile phones, autonomous vehicles, VR/AR devices, consumer electronics, robots, microscopes, and telescopes. This course discusses essential concepts and critical applications of computational imaging. Specifically, we focus on digital photography, AI techniques for computational imaging, optics, human perception, inverse problems in computational imaging. Students will implement each concrete example in Python. Students will learn the cutting-edge research in computational imaging and present them with attention to developing oral and written communication skills. Based on that, students will conduct their term project.

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 ·· (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.

CSED528 Optimization for Machine Learning ·· (3-0-3)

Recommended Prerequisites : MATH101 (Calculus) MATH230 (Probability and Statistics)

Optimization is a mathematical process of finding the optimal solution to a problem, and it plays a pivotal role in the process of performing machine learning to minimize the loss function and improve the performance of the model by adjusting the parameters of the model. First, we will lecture on the theory of convex optimization, and then cover the convergence analysis of key optimization algorithms. We will introduce the application of optimization in machine learning, and provide an in-depth understanding so that it can be utilized in deep learning and large-scale problems.

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.

CSED532 Applications of Mathematics and Big Data ·· (3-0-3)

Recommended Prerequisite : MATH230 (Probability and Statistcs)

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 ·· (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.

CSED537 Artificial Intelligence & Data Science ·· (3-0-3)

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 Deep Learning ·· (3-0-3)

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.

CSED539 Computer Vision ···································· (3-0-3)

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.

CSED540 Big Data Processing ···································· (3-0-3)

Recommended Prerequisites : CSED331 (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.

CSED541 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 faul modelling, test generation, fault simulation, testable design, and fault-tolerance circuits.

CSED551 Computational Photography ···································· (3-0-3)

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.

CSED554 Deep Learning NLP ···································· (3-0-3)

This course will cover cutting-edge research knowledge in deep learning natural language processing. Through lectures, students will learn the necessary skills to design, implement, and understand their own neural network models for various NLP problems such as word embedding/contextual word embedding, text classification, syntactic parsing, recurrent language modeling, machine translation, question answering, natural language generation, dialog systems, multi-task deep learning models, etc

CSED562 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.

CSED600 Distributed Processing ························ (3-0-3)

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 ························ (3-0-3)

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 ························ (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.

CSED603 Vision and Language ························ (3-0-3)

Recommended Prerequisites : CSED538 (Deep Learning), CSED539(Computer Vision

This course will explore topics between two active research areas in AI: Computer Vision (CV) & Natural Language Processing (NLP). As pictures and words are often naturally linked on the internet and in the real world, vision and language can reinforce information by aiding each other. For CV, text associated with images/videos and knowledge learned from language allows to better understand image. For NLP, images/videos help ground language in the physical world and develop better models for semantics. In this course, we will learn how to make use of the complementary nature of vision and language through topic lectures, presentation, and discussions about state-of-the-art research.

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.

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.

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.

CSED615 Advanced topics in Virtual Reality··**(3-0-3)**

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·· **(3-0-3)**

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 mutli-modal systems.

CSED617 Advanced Haptics···**(3-0-3)**

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.

CSED618 Trustworthy Machine Learning···**(3-0-3)**

Recommended Prerequisites : MATH230 (Probability & Statistics), CSED 515 (Machine Learning)

As machine learning models are impacting on real world environments (e.g., generative models), concerns on the trustworthiness of machine-learned models are rising. In this course, we explore whether popular machine-learned models are trustworthy and then study various learning methods to enchant the models to be trustworthy. To this end, we will learn basic knowledge on machine learning theory, uncertainty learning via conformal and selective prediction, adversarial examples/learning, machine unlearning, differentially private learning, fairness in learning, and miscellaneous topics on trustworthy AI.

CSED620 Mobile Networks·· **(3-0-3)**

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.

CSED621 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.

CSED626 Multimedia Networking ······ (3-0-3)

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 Reinforcement Learning ······ (3-0-3)

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.

CSED661 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.

CSED699 Master Thesis Research ······ (1~9)

CSED700A-Z Topics in Computer Science A-Z ······ (3-0-3)

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

CSED701A-Z Topics in Computation Theory A-Z ······ (3-0-3)

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

CSED702A-Z Topics in Computer Systems A-Z ······ (3-0-3)

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

CSED703A-Z Topics in Artificial Intelligence A-Z ······ (3-0-3)

This course covers advanced topics in artificial intelligence research.

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

CSED899 Doctoral Dissertation Research ······ (1~9)

[Common Subjects]

GEDU501 Scientific Writing for Graduate Students ········ **(3-0-2)**

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified.
Active discussion is encouraged to promote the participation of students.

GEDU502 Research paper Presentation Skill ········ **(3-0-2)**

The course will focus on professional presentations for international conferences.
Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers.
The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics ········ **(1-0-1)**

Research Ethics for responsible research of POSTECH graduate students Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ········ **(3-0-3)**

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ········ **(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 scientific and 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 in engineering practice.

MECH526 Transducer Theory & Its Applications ········ **(3-0-3)**

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

MECH531 Acoustics ··· (3-0-3)

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.

CHEB621 Advanced Thermodynacis ··· (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

AIGS537 Artificial Intelligence & Data Science·· (3-0-3)

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.

Department of Chemical Engineering

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

[Energy & Environment]

The Chemical Engineering department of POSTECH focuses on many researches involving new and renewable energy. Some of the topics include hydrogen economy preparation (production, storage and usage of hydrogen), fuel cells for power generation and domestic use, gas hydrate application, sunlight materials and power generation, Gas-to-liquid (GTL) technology that converts natural gas into base materials for chemical industry, biomass conversion, and petroleum conversion using catalyst.

It also conducts various environmental researches such as pollutant (Sox, NOx, Dioxin, etc.) removal, greenhouse gas management, carbon dioxide reduction, air pollutant removing catalyst, chemical and biological water pollution removal, pollutant-free chemical processes, and optimization of eco-industrial parks. Finally, it researches on secondary batteries to efficiently store new and renewable energy, and super-capacitors.

[Biotechnology]

Biotechnology is considered as one of the most successful collaborations of science and engineering. It is a cutting edge field of study which analyzes the phenomena of organisms, and applies these findings to create useful information and materials for humankind.

Recent developments in genetic engineering have created a critical turning point in biotechnology research. Biotechnology is now expected to be the most promising technology in the 21st century, and is recognized as perhaps the only technology to secure the safest future for people.

Acknowledging the potential, Korea has declared the year of 1994 as the first year of biotechnology development, and has selected it as one of the core fields of 21st century, anticipating pan-national support. Out of countless areas of relevant research, POSTECH focuses on biocatalyst engineering, cell culture engineering, molecular biotechnology, metabolic engineering, tissue engineering, biomaterials, and environmental biology.

[Material]

This field of study develops various organic and inorganic materials that make up electronic/optical devices used for storing and processing information, and researches chemical processes that arrange them in desired forms. Some of the main research topics include organic/inorganic thin film transistor (TFT), organic light emitting diode (OLED), semiconductor sensor, microarray, and organic/inorganic solar cells. POSTECH also conducts basic researches such as synthesizing new conducting materials or uniformly arranging atomic, molecular, or polymer materials on the surface of semiconductor through self-assembly.

[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:

Program	Course Credits	Research Credits	Overall Credit
Master's Program	18	10	28
Ph.D Program	15	17	32
M.S-Ph.D Integrated Program	24	36	60

[Notes on Completion of Course]

List of offered courses that award research credits.
- CHEB699 Master Thesis Research
- CHEB811 Graduate Seminar
- CHEB812 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)

Graduate Seminar(CHEB811A-Z)):
- For those in the master program: Should take each course twice or more
- For those in the M.S-Ph.D integrated program: Should take each course five times or more
- For those in the Ph.D program: Should take each course three times or more

Guide for GEDU501(CHEB802)
- Scientific Writing for Graduate Students(GEDU501/CHEB802) is mandatory for Ph.D. program and M.S/Ph.D integrated program.
- It is recognized only as a graduation requirement and excluded from graduation credits.

Guide for ICEC501
- Research Ethics for Graduate Students(ICEC501) is mandatory for the BK21 FOUR participating graduate students.
- It is recognized only as a graduation requirement and excluded from graduation credits.
- If you completed ICEC501 during a master's course, you do not need to register for this course.

3. Course Table

Category	Course No.	Course Title	Credit
Free Elective	GEDU501	Scientific Writing for Graduate Students	3-0-2
	ICEC501	Research Ethics	1-0-1
Major Elective	CHEB511	Catalysis	3-0-3
	CHEB551	Engineering Optimization	3-0-3
	CHEB553	Clean Process and Energy System	3-0-3
	CHEB561	Integrated Circuit Processing	3-0-3
	CHEB562	Carbon-based materials for energy storage	3-0-3
	CHEB563	Advanced Hydrogen Energy	3-0-3
	CHEB564	Advanced Nanoscale Fabrication and Manufacturing	3-0-3
	CHEB611	Advanced Reaction Engineering	3-0-3
	CHEB621	Advanced Thermodynamics	3-0-3
	CHEB631	Advanced Biochemical Engineering	3-0-3
	CHEB641	Advanced Chemical Engineering Mathematics	3-0-3
	CHEB642	Advanced Transport Phenomena	3-0-3
	CHEB643	Advanced Metabolic Engineering	3-0-3
	CHEB644	Transcriptional Regulation for Synthetic Biotechnology	3-0-3
	CHEB645	Protein Biosynthesis	3-0-3
	CHEB646	Advanced Synthetic Biology	3-0-3
	CHEB661	Advanced Polymer Engineering	3-0-3
	CHEB713	Chemical Reactor Analysis and Design	3-0-3
	CHEB722	Surface and Interface of Materials	3-0-3
	CHEB737	Advanced Molecular Biotechnology	3-0-3
	CHEB738	Introduction of Marine Environments and Biotechnology	3-0-3
	CHEB744	Statistical Fluid Mechanics	3-0-3
	CHEB745	Numerical Analysis in Chemical Engineering	3-0-3
	CHEB746	Molecular Simulation for Chemical Engineers	3-0-3
	CHEB751	Advanced Process Design	3-0-3
	CHEB752	Process Synthesis and Analysis	3-0-3
	CHEB760	Polymer Blends	3-0-3
	CHEB763	Conducting Polymers and Characterization	3-0-3
	CHEB766	Advanced Organic Material Chemistry	3-0-3
	CHEB768	Ceramic Materials Processing	3-0-3
	CHEB769	Semiconductor Materials Processing	3-0-3
	CHEB770	Semiconductor Materials and Devices	3-0-3
	CHEB776	Interface and Adhesion for Electronic & Information Materials	3-0-3
	CHEB777	Advanced Functional Nanomaterials	3-0-3
	CHEB781	Photocatalysis for Energy and Environmental Applications	3-0-3
	CHEB801A-Z	Special Topics in Chemical Engineering	credits varies
Research	CHEB699	Master Thesis Research	credits varies
	CHEB811A-Z	Graduate Seminar	1-0-1
	CHEB812	Project Research for R&D of School-Industry Cooperation	0-0-9
	CHEB899	Doctoral Dissertation Research	credits varies

4. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	
				Research Ethics	
			Major Elective	Current Trends in Chemistry (CHEM)	
				Electrochem. for Energy Applications (AMSE)	
				Applied Numerial Methods (MECH)	
				Transducer Theory & Its Applications (MECH)	
				Acoustics (MECH)	
				A Study on Interplays of Human. & Tech. (CITE)	
				Conv. Imagination & Design Thinking of Eng. (CITE)	
				Intro. to Environmental Eng. (EVSE)	
				Aritificial Intelligence & Data Science (AIGS)	
Dept.	Common Subjects		Research Credit	Graduate Seminar A-Z	· For those in the M.S program: Should take twice or more . For those in the Ph.D program: Should take three times or more · For those in the M.S-Ph.D integrated program: Should take five times or more
	Core Requirements (recommended)		Major Elective	Advanced Reaction Engineering	1 course is recommended
				Advanced Thermodynacis	
				Advanced Transport Phenomena	
	Core Electives (by Major)	Energy & Environ ment	Major Elective	Semiconductor Materials Processing	
				Advanced Functional Nanomaterials	
				R. Prog. in Prep.& Cha.of Hete. Cata.	
				Soft Matter Interface Engineering	
				New and Renewable Energy System Eng.	
				Light Scattering of Colloidal Dispersion	
				Sensor Eng.	
				Molecular Simulation for Chemical Engineers	
		Biotech nology	Major Elective	Advanced Biochemical Engineering	
				Advanced Metabolic Engineering	
				Transciptional Regulation for Synthetic Biotechnology	
				Protein Biosynthesis	
				Advanced Synthetic Biology	
				Advanced Molecular Biotechnology	
				Crit. of Recent Research on Biotech.	
				Project Research for R&D of School-Industry Cooperation	
		Material s	Major Elective	Polymers Blends	
				Advanced organic Material Chemistry	
				Interface and Adhesion for Electronic & Infromation Materials	
				Special Topics in Organic Electronics	
				Nano Materials for Electronics	
				Smart Soft Matter Engineering	
				Solid Structure&Properties of Polymers	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

5. Departmental Curriculum Roadmap

Major	Category	Course Title
Energy & Environment	Common Course	Scientific Writing for Graduate Students, Research Ethics
	Dept. Core Required Electives (recommended)	Advanced Reaction Engineering, Advanced Thermodynacis, Advanced Transport Phenomena
	Major Electives by major	Semiconductor Materials Processing, Advanced Functional Nanomaterials, R. Prog. in Prep.& Cha.of Hete. Cata., Soft Matter Interface Engineering, New and Renewable Energy System Eng., Light Scattering of Colloidal Dispersion, Sensor Eng. Molecular Simulation for Chemical Engineers
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Biotechnology	Common Course	Scientific Writing for Graduate Students, Research Ethics
	Dept. Core Required Electives (recommended)	Advanced Reaction Engineering, Advanced Thermodynacis, Advanced Transport Phenomena
	Major Electives by major	Advanced Biochemical Engineering, Advanced Metabolic Engineering, Transciptional Regulation for Synthetic Biotechnology, Protein Biosynthesis, Advanced Synthetic Biology, Advanced Molecular Biotechnology, Crit. of Recent Research on Biotech., Project Research for R&D of School-Industry Cooperation
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Materials	Common Course	Scientific Writing for Graduate Students, Research Ethics
	Dept. Core Required Electives (recommended)	Advanced Reaction Engineering, Advanced Thermodynacis, Advanced Transport Phenomena
	Major Electives by major	Polymers Blends, Advanced organic Material Chemistry, Interface and Adhesion for Electronic & Infromation Materials, Special Topics in Organic Electronics, Nano Materials for Electronics, Smart Soft Matter Engineering, Solid Structure&Properties of Polymers
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

6. Course Description

CHEB511 Catalysis ··· (3-0-3)

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

CHEB551 Engineering Optimization ··· (3-0-3)

Mathematical formulation and its solution methods of optimization problems in chemical process are treated. Linear Programming, Nonlinear Programming, Mixed Integer Programming, multi variable optimization and constraints are dealt with practical examples.

CHEB553 Clean Process and Energy System ··· (3-0-3)

Specific energy/environmental processes, e.g., water purification process, are studied thoroughly from the view points of chemical engineering, environmental engineering, and energy engineering.

CHEB561 Integrated Circuit Processing ······ (3-0-3)

Basic principles involved in silicon integrated circuit manufacturing are covered. Unit processes such as crystal growth, cleaning, oxidation, diffusion, vapor deposition for thin films, etching, lithography, ion implantation and metalization are included.

CHEB562 Carbon-based materials for energy storage ······ (3-0-3)

In order to design functional carbon-based materials for energy storage applications, it is important to understand the intrinsic properties of carbon and the strategies to make better materials. In this course, we will study the basic structural features of carbon and electrochemical energy storage systems which utilize various carbon materials. Students will study general electrochemistry and various techniques for nanomaterials' preparation, characterizations, and its energy storage applications.

CHEB563 Advanced Hydrogen Energy ······ (3-0-3)

Hydrogen (H_2) is gaining attention as a sustainable energy carrier and has recognized as a key technology for achieving carbon neutrality. This lecture provides an in-depth exploration of the latest research trends in hydrogen production, storage/transportation, and utilization technologies, aiming to enhance both theoretical understanding and practical application skills in these core areas. Specifically, the hydrogen production section covers various hydrogen generation methods, including fossil fuel-based reforming technologies and water electrolysis, along with the latest advancements in the field. The hydrogen storage/transportation section introduces chemical hydrogen storage technologies such as liquid organic hydrogen carriers (LOHCs) and ammonia (NH_3), providing insights into the global hydrogen supply chain and infrastructure for storage and transportation. The hydrogen utilization section focuses on fuel cell technologies and hydrogen/ammonia turbine systems, analyzing their applications in power generation and industrial processes. Finally, the future innovation technology section introduces carbon-neutral fuel production using CO_2-free hydrogen and captured carbon, highlighting emerging advancements in sustainable energy solutions. This lecture covers a broad spectrum of topics, from the fundamental scientific principles of hydrogen energy to its industrial applications. It also includes invited lectures from external experts and provides opportunities for students to analyze and present the latest research papers and technological developments. Through this approach, students will gain a comprehensive understanding of state-of-the-art hydrogen technologies and develop the expertise necessary to apply them in research and industrial settings.

CHEB564 Advanced Nanoscale Fabrication and Manufacturin ······ (3-0-3)

Prerequisite: Intro.to Nanoscale Science & Engineering

Nanoscale science and engineering involve refining the functional properties of materials, devices, or systems with at least one dimension in the 1-100 nm range. Recent advancements in nanoscience have revolutionized multiple fields, driving innovations in healthcare, energy, computing, and communications. This course explores cutting-edge technologies influenced by breakthroughs in nanoscale research, including nanoelectronics, nanooptics, nanophotonics, nanomagnetics, nanomechanical systems, and nanosensors. A key focus is on understanding the theory, design, fabrication, characterization, and application of various nanomaterials and nanostructures. The course also covers state-of-the-art nanofabrication techniques, including advanced lithography, atomic layer deposition (ALD), self-assembly methods, and emerging hybrid approaches that integrate top-down and bottom-up fabrication strategies. Furthermore, students will explore various applications enabled by nanoscale fabrication, such as high-performance optical components, next-generation semiconductor devices, advanced sensors, and bio-integrated nanotechnology. Through this, students will gain a comprehensive understanding of how nanofabrication techniques contribute to real-world technological advancements.

CHEB611 Advanced Reaction Engineering ······ **(3-0-3)**

Instruction on chemical kinetics and reactor design. Course covers derivation of rate law, application of reaction kinetics for reactor design, analysis and design of reactors in homogeneous and heterogeneous phase. Application examples cover catalytic reactors, biochemical reactors, CVD reactors and polymerization reactors.

CHEB621 Advanced Thermodynamics ······ **(3-0-3)**

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

CHEB631 Advanced Biochemical Engineering ······ **(3-0-3)**

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

CHEB641 Advanced Chemical Engineering Mathematics ······ **(3-0-3)**

Mathematical methods for solving chemical engineering problems: linear operator theory, eigen-function expansion, special functions, Green's function, spherical harmonics, integral transform, integral equations.

CHEB642 Advanced Transport Phenomena ······ **(3-0-3)**

Flow and transport phenomena in microsystems: equations of changes for mass, momentum, and energy, Stokes flow, Brownian diffusion, effective transport property, flow with electrostatic body force, inter-particle forces, electrical double layer, electrokinetics, micro-fluidics.

CHEB643 Advanced Metabolic Engineering ······ **(3-0-3)**

This course deals with the redesign of biological systems in the level of metabolism and covers the basic review of metabolism and various experimental methods to understand metabolic pathways. In addition, applications to industrial, medical, and agricultural biotechnology are illustrated.

CHEB644 Transcriptional Regulation for Synthetic Biotechnology ······ **(3-0-3)**

This course aims to provide intensive knowledge of transcription mechanism and regulation system for synthetic biology especially for the purposeful redesign of the biological system.

CHEB645 Protein Biosynthesis ······ **(3-0-3)**

This is an intensive course to study protein synthesis mechanism as well as regulation network in the biological system.

CHEB646 Advanced Synthetic Biology ··· (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.

Lectures: Surface Energy, Contact Angle, Self-Assembled Monolayers, Langmuir Blodgett Films, Atomic Layer Deposition, Crystal Nucleation and Growth, Adhesion, Surface Characterizations

CHEB737 Advanced Molecular Biotechnology ··· (3-0-3)

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

CHEB738 Introduction of Marine Environments and Biotechnology ··· (3-0-3)

Marine covers about 80% of the earth and is mainly undiscoverable area. Lecture consists of two parts: the first half instruction is introduction of marine environment and importancy and the latter half is introduction of biotechnology researches using marine organisms and their applications.

CHEB744 Statistical Fluid Mechanics ··· (3-0-3)

Micro-hydrodynamics for colloidal suspension and polymer solution: multi-pole expansion, singularity solution method, integral representation, reciprocal theorem, Lamb's solution, multivariate Gaussian distribution, ergodic hypothesis, Fokker-Planck equation, re-normalization method.

CHEB745 Numerical Analysis in Chemical Engineering ··· (3-0-3)

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.

CHEB746 Molecular Simulation For Chemical Engineers······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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.

CHEB770 Semiconductor Materials and Devices······ **(3-0-3)**

This course will provide a fundamental understanding of emerging semiconductors (metal oxide, perovskite, organic) and related device physics based on a solid understanding of silicon semiconductors and device physics.

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

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

CHEB777 Advanced Functional Nanomaterials ·· (3-0-3)

New research trends in Chemical Engineering are introduced.

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

To understand the basic principles and characteristics of semiconductor photo-catalysis and review and discuss a wide range of related research papers.

CHEB801A-Z Special Topics A-Z ·· (credits varies)

New research trends in Chemical Engineering are introduced.

CHEB811A-Z Graduate Seminar A-Z ·· (1-0-1)

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

CHEB812 Project Research for R&D of School-Industry Cooperation ································· (0-0-9)

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 ·· (1~9)

Experimental and theoretical research in all areas of chemical engineering needed for.

GEDU501 Scientific Writing for Graduate Students ·· (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified.
Active discussion is encouraged to promote the participation of students.

ICEC501 Research Ethics ·· (1-0-1)

A research ethics course for responsible research of POSTECH graduate students. This course covers the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community.

Department of Convergence IT Engineering

1. Education Aim

The graduate program of Convergence IT Engineering (CiTE) aims to develop ICT-based convergence research and self-directed future leaders based on 'Public & Social Interest Emerging Technology' with engineering education based on creative imagination, convergent investigation, and transformative innovation. To this end, IT convergence talent training such as IT convergence technology education, problem-solving skills education, and value-building education will be conducted.

2. Program Overview

POSTECH's CiTE provides in-depth education on areas of individual interest, and basic education on areas of humanities, social sciences, and arts to develop innovative technologies that pursue public and social values by converging Artificial Intelligence technologies with the three key research areas: IT-based Future Healthcare, Human Technology Design and Intelligent Systems. CiTE encourages creative and convergent research activities through the interaction of science, engineering, and humanities based on new intellectual capabilities obtained through IT convergence education and research in various fields.

A. Degree requirements

Degree Program	Course Credits	Research Credits	Total Credits
Master's program	15	13	28
Doctoral program	12	20	32
MS/PhD integrated program	27	33	60

B. Guidelines for Coursework

1) Course credit requirements for a graduate degree may be fulfilled by:
  - Graduate courses from CiTE and/or other departments at POSTECH
  - Undergraduate courses from CiTE and/or other departments at POSTECH
    ※ 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.)
  - Credits from Master's Thesis/Doctoral Dissertation Research courses and Seminar courses may not be counted toward course credits.

- If a CiTE graduate student takes undergraduate(excluding liberal arts) or graduate courses, student can change grading scale from letter grade to S/U. However, for master's and doctoral program up to 3 credits respectively, and for MS/PhD Integrated Program up to 6 credits can possibly be counted with S/U.
- It is recommended for students who did not receive an undergraduate degree from CiTE to take undergraduate Creative Studio courses.

2) Required courses

① GEDU501 Scientific Writing: Mandatory course for master's, doctoral and integrated program

② GEDU502 Research Paper Presentation Skill: Mandatory course for doctoral and integrated program

※ The above two courses are not included in both graduation credits and GPA average. (Entrants from 2022)

③ CITE599 Creative IT Colloquium(Research course): Mandatory course for master's(1 credit), doctoral(2 credits) and integrated program(2 credits) to enrolled students from 2021.

④ ICEC501 Research Ethics: Mandatory course for master's, doctoral and integrated program (Entrants from 2024) *Not included in graduation credits.

3. Course List

Category	Course Number	Course Title	Lec-Lab-Cr
Course Electives	CITE521/CSED504/AIGS504	Advanced Operating System	3-0-3
	CITE522/CSED518/AIGS518	Linguistics Basis for Natural Language Processing	3-0-3
	CITE523/CSED521	Fuzzy and Intelligent System	3-0-3
	CITE524/CSED526/AIGS526	Data Mining	3-0-3
	CITE531/EECE553	Introduction to Neural Networks	3-0-3
	CITE533/EECE564	Linear System Theory	3-0-3
	CITE534/EECE571	VLSI System Design	3-0-3
	CITE535/EECE579	Information and Communication Security	3-0-3
	CITE538	Intelligent Robotics	3-0-3
	CITE539/EECE563/PCFT702	Quantum Mechanics for Applied Nanotechnology	3-0-3
	CITE540/NUCE718W	Social Problem Solving & Hazardous Robotics	3-2-4
	CITE541/EECE568	Optimal Control Theory	3-0-3
	CITE551/EECE559/MECH536/IBIO530/PMSE651/SDST551	Principles of Biomedical Opt. & Imaging	3-0-3
	CITE552/MECH532	Tissue Eng. for Mechanical Engineers	3-0-3
	CITE553/EECE591/MECH538/IBIO538/PMSE553	Medical Device Design Process	3-0-3
	CITE554/MECH537/IBIO535/PMSE554	Personalized Medicine for Engineers	3-0-3
	CITE555/IBIO537/PMSE555	Ultrasonics	3-0-3
	CITE611	A Study on Interplays of Human.&Tech.	3-0-3
	CITE612	Conv. Imagination & Design Thinking of Eng.	3-0-3
	CITE621/CSED605	Real-time Systems	3-0-3
	CITE622/CSED610	Information Retrieval	3-0-3

Category	Course Number	Course Title	Lec-Lab-Cr
	CITE623/CSED611	Machine Translation	3-0-3
	CITE631/EECE651/AIGS651	Computational Intelligence	3-0-3
Course Electives	CITE632/EECE653	Semiconductor Fabrication Processing	3-0-3
	CITE633/EECE659	Nonlinear System Theory	3-0-3
	CITE635/EECE667	Circuit Analysis Algorithms and Software	3-0-3
	CITE636/EECE672	Linear Optimal Control	3-0-3
	CITE637/EECE637/PCFT707	Phys. & Characterization of Next-Gen. Devices	3-0-3
	CITE700A-Z	Special Topics in CiTE	Variable Credit
Common Subjects	GEDU501	Scientific Writing	3-0-2
	GEDU502	Research Paper Presentation Skill	3-0-2
	ICEC501	Research Ethics	1-0-1
Research Electives	CITE599	Creative IT Colloquium	1-0-1
	CITE699	Master Thesis Research	Variable Credit
	CITE899	Doctoral Dissertation Research	Variable Credit

4. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	**Common Subjects**		**Free Elective**	Scientific Writing for Graduate Students	
			Free Elective	Research Paper Presentation Skill	
			Free Elective	Research Ethics	
Dept.	**Core Requirements (or Electives)**		**Research**	Creative IT Colloquium	
	Core Electives (by Major)	**Human Technology Design**	**Major Elective**	Convergence Imagination & Design Thinking of Engineering	
			Major Elective	A Study on Interplays of Humanities and Technology	
			Major Elective	Engineering Ethics and Communication	
			Major Elective	Making Intro. for Graduate Research	
			Major Elective	Social Problem Solving & Hazardous Robotics	
			Major Elective	Future Strategy for Science & Technology	
		Intelligent Systems	**Major Elective**	Advanced Operating System	
			Major Elective	Computational Intelligence	
			Major Elective	Linguistics Basis for Natural Language Processing	
			Major Elective	Data Mining	
			Major Elective	Information Retrieval	
			Major Elective	Machine Translation	
			Major Elective	Information and Communication Security	
			Major Elective	Parallel Programming	
			Major Elective	Circuit Analysis Algorithms and Software	
			Major Elective	VLSI System Design	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	Intelligent Systems	Major Elective	Linear Optimal Control	
			Major Elective	Intelligent Robotics	
			Major Elective	Quantum Mechanics for Applied Nanotechnology	
			Major Elective	Battery Informatics	
			Major Elective	Automotive Battery and Its System	
			Major Elective	Linear System Theory	
			Major Elective	Nonlinear System Theory	
			Major Elective	Semiconductor Fabrication Processing	
			Major Elective	Nanoscale Dev. Simul. & Measurement	
			Major Elective	Physics & Characterization of Next-generation Devices	
		IT-based Future Healthcare	Major Elective	Business Plan Development in Biomedicine	
			Major Elective	Image Processing and Computing System	
			Major Elective	Principles of Biomedical Opt. & Imaging	
			Major Elective	High-Performance Algorithm in GPU/DSP/CPU	
			Major Elective	Adv. Signal/Image Processing in CPU/DSP/GPU	
			Major Elective	Advanced Medical Device Technology	
			Major Elective	Medical Device Design Process	
			Major Elective	Bioprinting & Tissue Engineering Lab.	
			Major Elective	Tissue Eng. for Mechanical Engineers	
			Major Elective	Personalized Medicine for Engineers	
			Major Elective	Ultrasonics	
			Major Elective	Ultrasonic Transducers	
			Major Elective	Innovative Medical Dev. Tech. Seminar	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

5. Departmental Curriculum Roadmap

Major	Category	Course Title
Human Technology Design	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Creative IT Colloquium, A Study on Interplays of Humanities and Technology, Making Intro. for Graduate Research
	Major Electives by major	Convergence Imagination & Design Thinking of Engineering, Engineering ethics and communication, Social Problem Solving & Hazardous Robotics, Future Strategy for Science & Technology
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
Intelligent Systems	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Creative IT Colloquium, Linear System Theory, Physics & Characterization of Next-generation Devices
	Major Electives by major	Advanced Operating System, Computational Intelligence, Linguistics Basis for Natural Language Processing, Data Mining, Information Retrieval, Machine Translation, Information and Communication Security, Parallel Programming, Circuit Analysis Algorithms and Software, VLSI System Design, Linear Optimal Control, Intelligent Robotics, Quantum Mechanics for Applied Nanotechnology, Battery Informatics, Automotive Battery and Its System, Nonlinear System Theory, Semiconductor Fabrication Processing, Nanoscale Dev. Simul. & Measurement
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
IT-based Future Healthcare	Common Course	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Research Ethics
	Dept. Core Required Electives	Creative IT Colloquium, Innovative Medical Dev. Tech. Seminar
	Major Electives by major	Business Plan Development in Biomedicine, Image Processing and Computing System, Principles of Biomedical Opt. & Imaging, High-Performance Algorithm in GPU/DSP/CPU, Adv. Signal/Image Processing in CPU/DSP/GPU, Advanced Medical Device Technology, Medical Device Design Process, Bioprinting & Tissue Engineering Lab., Tissue Eng. for Mechanical Engineers, Personalized Medicine for Engineers, Ultrasonics, Ultrasonic Transducers
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

6. Course Description

CITE521/CSED504/AIGS504 Advanced Operating System ························ (3-0-3)

Recommended Prerequisites: CSED312(Operating System)

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.

CITE522/CSED518/AIGS518 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.

CITE523/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.

CITE524/CSED526/AIGS526 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.

CITE531/EECE553 Introduction to Neural Networks ························ (3-0-3)

Prerequisites: EECE233(Signals and Systems), CSED321(Programming language)

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.

CITE533/EECE564 Linear System Theory ························ (3-0-3)

Prerequisites: EECE322(Automatic Control Theory), MATH203(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.

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.

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/EECE563/PCFT702 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 majoring 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/NUCE718W Social Problem Solving & Hazardous Robotics ··· **(3-2-4)**

This course 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.

CITE541/EECE568 Optimal Control Theory ··· **(3-0-3)**

Prerequisites: CITE533/EECE564(Linear System Theory)

This course covers an introductory account of the theory of optimal control and its applications which will provide the students with the background necessary for sound understanding of the optimal control systems.

CITE551/EECE559/MECH536/IBIO530/PMSE651/SDST551 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 physiochemical 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/EECE591/MECH538/IBIO538/PMSE553 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.

CITE554/MECH537/IBIO535/PMSE553 Personalized Medicine for Engineers························· (3-0-3)

Doctors have long known that people differ in susceptibility to disease and response to medicines. However, with little guidance for understanding and adjusting to individual differences, treatments developed have generally been standardized for the many, rather than the few. To overcome the current limitation, through this course, students will learn how engineering and science change medicines, what the benefits of personalized medicine are, and what the role of engineers in creating personalized medicine is.

CITE555/IBIO537/PMSE553 Ultrasonics·· (3-0-3)

Recommended Prerequisites: CITE490J/IBIO533(Biomedical Systems&Signal Processing), Engineering Mathematics (particularly Fourier Transforms), MATLAB

This course provides graduate or senior undergraduate students with fundamental physical principles and instrumentation in ultrasound imaging and therapeutics. Students learn the physics of ultrasound and core properties related to imaging and therapeutic applications, how to design, fabricate and evaluate ultrasound transducers, and how to form the images with the array-based beamforming system. They also explore advanced imaging methods and understand their advantages and limitations. Special topics including the biological effects of ultrasound and therapeutic applications, high-frequency ultrasound imaging, and cell mechanics studies are also covered.

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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: CITE521/CSED504/AIGS504(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: CITE522/CSED518/AIGS518(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: CITE522/CSED518/AIGS518(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/AIGS651 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.

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: CITE533/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.

CITE635/EECE667 Circuit Analysis Algorithms and Software ··· (3-0-3)

Prerequisite: EECE273(Digital System Design), CITE534/EECE571(VLSI System Design)

This class aims to provide the background on the computer methods and algorithms for VLSI analysis and design, which helps improve the design abilities of VLSI designers. In the class, the current status of Electronic Design Automation is briefly introduced. Then, various computer algorithms, numerical analysis methods, and graph theory, which are associated with the computer-aided software for the analysis and design of VLSI systems, are discussed. Both theories and applications are discussed, and class projects provide students with chances to have hands-on experiences for software development.

CITE636/EECE672 Linear Optimal Control ··· (3-0-3)

Prerequisite: CITE533/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/PCFT707 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.

CITE700A-Z Special Topics A-Z·· (variable credit)

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.

GEDU501 Scientific Writing for Graduate Students··· (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing. To this end, published papers are analyzed and their characteristics are identified. Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill·· (3-0-2)

The course will focus on professional presentations for international conferences. Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers. The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics··· (1-0-1)

Research Ethics for responsible research of POSTECH graduate students Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications··· (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ········ **(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 scientific and 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 in engineering practice.

MECH526 Transducer Theory & Its Applications ········ **(3-1-3)**

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

MECH531 Acoustics ········ **(3-0-3)**

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.

CHEB621 Adv. Thermodynamics ········ **(3-0-3)**

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

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.

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.

CITE599 Creative IT Colloquium ········ **(1-0-1)**

In this course, experts from various fields provide basic skills for interdisciplinary scientific and technical research.

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.

CITE899 Doctoral Dissertation Research ·· **(variable credit)**

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 Semiconductor Engineering

1. Learning Goal

The educational goal of the graduate program in Semiconductor Engineering at POSTECH is to nuture globally competitive semiconductor professionals who possess exceptional research ability, creativity, academic excellence, and leadership. To achieve this goal, the department offers a curriculum that enables students to cultivate in-depth knowledge and practical proficiency in various aspects of semiconductor engineering, ranging from devices, processes, design, to systems. Additionally, the program provides profound research experiences at the forefront of cutting-edge technologies.

2. Program Overview

The graduate program in Semiconductor Engineering provides students pursuing master's and doctoral degrees with high-quality education by offering a wide range of courses and research opportunities in various fields of semiconductor engineering. The educational objectives and associated research areas within each field can be broadly categorized as follows:

[Semiconductor Materials, Devices, and Processes]

The department offers courses that delve into semiconductor fabrication and electrical characterization, enabling research on semiconductor materials, devices, and processes. It operates multiple research labs focusing on key research areas such as intelligent semiconductor devices, display devices, nano and energy devices, applied sensors, solid-state electronics, quantum computing and quantum networking, and wearable devices.

[Semiconductor Circuits and VLSI Design]

The department engages in education and research on semiconductor-related design and application technologies, equipped with an assortment of circuit design software and measurement equipment. VLSI (Very Large Scale Integration) design encompasses the field of designing and fabricating new integrated circuit chips, followed by performance measurements. It also involves research on SoC (System-on-Chip) applications, design techniques, and automation of SoC design.

A. Credits Required for Graduation

Programs	Course Credit	Research Credit	Overall Credit
Master’s Program	21 Credits	7 Credits	28 Credits
MS/PhD Integrated Program	30 Credits	30 Credits	60 Credits

B. Required to all students

1) A must-have graduate school course
- Master's Program: The research credits are fulfilled by taking SEMI699 Master's Thesis Research.
- MS/PhD Integrated Program: The research credits are fulfilled by taking SEMI899 Doctoral Dissertation Research and SEMI701 Semiconductor Engineering Seminar. SEMI701 Semiconductor Engineering Seminar is a mandatory course that must be taken for at least two semesters.

2) The graduate curriculum includes the following courses for course credits.
- Graduate Courses in Semiconductor Engineering
- Graduate Courses from Other Departments
- Undergraduate Courses in Semiconductor Engineering and Courses in Other Majors from Different Departments (200-400 Level Courses, Up to 6 Credits Transferable)

(1) Undergraduate course credits
- ‣ Recognition of 200-400 Level Courses, up to 6 Credits, as Graduation Credits for the Undergraduate Program in Semiconductor Engineering and Other Majors
- ‣ The grading system can be selected as either G (Letter Grade) or S (pass) / U (failed).
- ‣ However, enrollment must be conducted under the professor's guidance.

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

3) Recommended English proficiency requirements for graduate studies
- GEDU501 Graduate English Thesis Writing: Enrollment in this course is recommended and the credits earned count as graduation credits (a major elective).

3. Course Table

Category	Course No.	Course Title	lec-lab.-cr.
Select Major	SEMI521/EECE592	Semiconductor Transport Theory	3-0-3
	SEMI522	Advanced Logic Semiconductor Device	3-0-3
	SEMI523	Memory Technology and Statistics	3-0-3
	SEMI524	Electronic Thin Film Science	3-0-3
	SEMI541/EECE569	Analog Integrated Circuits	3-0-3
	SEMI542/GSST513	Chip-to-chip IO design	3-0-3
	SEMI561	Advanced Semiconductor Processes	3-0-3
	SEMI562	Thin Film Process Technology	3-0-3

Category	Course No.	Course Title	lec-lab.-cr.
	SEMI621/GSST623/QIST655	Topological Material Information Devices	3-0-3
	SEMI641/EECE667	Circuit Analysis Algorithms and Software	3-0-3
	SEMI690A-Z	Advanced Topics in Semiconductor Eng.	Variable Credit
Research Subject	SEMI699	Master Thesis Research	Variable Credit(1-9)
	SEMI701	Semiconductor Engineering Seminar	1-0-1
	SEMI899	Doctoral Dissertation Research	Variable Credit(1-9)

4. Major Field Courses Listed by Category

Classification		Category	Course Title	Remarks
Univ.	Common Subjects	Major Elective	Graduate English Thesis Writing	
		Free Elective	Research paper Presentation Skill	
		Free Elective	Research Ethics	
		Major Elective	Current Trends in Chemistry	
		Major Elective	Electrochemistry for Energy Applications	
		Major Elective	Applied Numerical Methods	
		Major Elective	Transducer Theory & Its Applications	
		Major Elective	Acoustics	
		Major Elective	Advanced Thermodynacis	
		Major Elective	A Study on Interplays of Humanities and Technology	
		Major Elective	Convergence Imagination & Design Thinking of Engineering	
		Major Elective	Introduction to Environmental Engineering	
		Major Elective	Artificial Intelligence & Data Science	
Dept.	Core Required	Research Credits	Semiconductor Engineering Seminar	Designated as a Required Course (Completion of Two or More Integrative Courses)
		Research Credits	Master Thesis Research	
		Research Credits	Doctoral Dissertation Research	

Classification			Category	Course Title	Remarks
	Core Elective (by Major)	Semiconductor Materials, Devices, and Processes	Major Elective	Semiconductor Transport Theory	
				Advanced Logic Semiconductor Device	
				Memory Technology and Statistics	
				Electronic Thin Film Science	
				Thin Film Process Technology	
				Advanced Semiconductor Processes	
				Topological Material Information Devices	
		Semiconductor Circuits and VLSI Design	Major Elective	Analog Integrated Circuits	
				Circuit Analysis Algorithms and Software	
				Chip-to-chip IO design	
	Interdisciplinary Electives		Major Elective	Related Department, Undergraduate and Graduate Course Offerings	Up to 6 Credits Recognized for Undergraduate Program

5. Departmental Curriculum Roadmap

Major	Classification	Course Title
Semiconductor Materials, Devices, and Processes	Common Subjects	Graduate English Thesis Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Advanced Thermodynacis, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & Data Science
	Core Required	Semiconductor Engineering Seminar
	Major Elective by major	Semiconductor Transport Theory, Advanced Logic Semiconductor Device, Memory Technology and Statistics, Electronic Thin Film Science, Thin Film Process Technology, Advanced Semiconductor Processes, Topological Material Information Devices, Advanced Topics in Semiconductor Eng.
	Interdisciplinary Electives	Related Department Undergraduate and Graduate Course Offerings
Semiconductor Circuits and VLSI Design	Common Subjects	Graduate English Thesis Writing, Research paper Presentation Skill, Research Ethics, Current Trends in Chemistry, Electrochemistry for Energy Applications, Applied Numerical Methods, Transducer Theory & Its Applications, Acoustics, Advanced Thermodynacis, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering, Artificial Intelligence & Data Science

Major	Classification	Course Title
	Core Required	Semiconductor Engineering Seminar
	Major Elective by major	Analog Integrated Circuits, Circuit Analysis Algorithms and Software, Chip-to-chip IO design, Advanced Topics in Semiconductor Eng.
	Interdisciplinary Electives	Related Department, Undergraduate and Graduate Course Offerings

6. Course Description

GEDU501 Scientific Writing for Graduate Students ······································ (3-0-2)

This is a course in writing scientific papers in English. It is a 12-week, credit course for Gradaute 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 hilp in this process. There will be no formal examinations; all marks will be based on exercises, assignments, and the final manuscript.

GEDU502 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 verb+ ally; how to produce effective graphics, and how to express their ideas in good English. Students will also improve their English grammar, vocabulary and diction.

ICEC501 Research Ethics ······································ (1-0-1)

Research Ethics for responsible research of POSTECH graduate students Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.

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.

AMSE513 Electrochemistry for Energy Applications ······································ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ························· (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 scientific and 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 in engineering practice.

MECH526 Transducer Theory & Its Applications ························· (3-1-3)

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

MECH531 Acoustics ························· (3-0-3)

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.

CHEB621 Advanced Thermodynacis ························· (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

SEMI521/EECE592 Semiconductor Transport Theory··································· (3-0-3)

This graduate-level theoretical course delves into the theoretical aspects of charge transport within semiconductors. It covers essential topics such as quantum mechanics, statistical mechanics, and solid-state mechanics, catering to varying levels of students' backgrounds. The course includes the study of energy band structure calculation methods in semiconductors and the interpretation of discrepancies between actual and calculated band structures. Students develop an understanding of critical concepts in semiconductor transport theory, such as effective mass, density of states, and the Boltzmann transport model considering charge and phonon scattering. Additionally, the course explores the calculation of transport characteristics using the non-equilibrium Green's function method considering quantum mechanical effects.

SEMI522 Advanced Logic Semiconductor Device·· (3-0-3)

The course focuses on semiconductor materials, processes, and device technologies to provide an in-depth understanding of Si-based logic semiconductor devices from the 90nm node to sub-3nm nodes (More Moore), as well as exploring novel concepts (Beyond Moore) in logic semiconductor devices.

SEMI523 Memory Technology and Statistics··· (3-0-3)

The course aims to provide a comprehensive understanding of the fundamental operations and key functionalities of highly integrated memory semiconductor devices, consisting of billions of unit memory cells. The course introduces the basic concepts of statistical probability in addition to explaining how the entire semiconductor system operates and makes decisions. Starting with DRAM and expanding to SRAM and NAND flash, the course covers a broad understanding of memory semiconductor devices. Beyond individual device behavior, students will gain insights into the impact on overall yield. Furthermore, the course covers methods for determining cell addresses, understanding sense amplifier circuits, and expanding them into SRAM and NAND flash technologies. The goal is to comprehend the correlation between unit devices and the overall distribution. In the final stage, students apply their knowledge to evaluate the advantages and disadvantages of next-generation memory semiconductor devices currently under research.

SEMI524 Electronic Thin Film Science ······ (3-0-3)

Semiconductor devices exhibit their intended functions and performance through the three-dimensional stacking structure of various thin films. The thin films constituting semiconductor devices are formed on substrates and possess larger non-surface area and interfaces and different physical/chemical properties compared to the bulk material. In this course, students learn about the growth mechanisms, surface effects, and electrical/mechanical/thermal/optical properties of semiconductor thin films, as well as the principles for measuring these properties. The course aims to develop the capabilities to utilize the growth mechanisms and properties of semiconductor thin films for the development of semiconductor devices.

SEMI541/EECE569 Analog Integrated Circuits ······ (3-0-3)

Prerequisite Courses: Electronic Circuits I, Electronic Circuits II

In this course, students learn CMOS analog integrated circuit design techniques through hand analysis and SIGMA-SPICE simulation. They review the operation of single transistor amplifiers such as CS, CG, and CD, and study frequency characteristics, frequency stability, noise analysis, bandgap voltage references, voltage regulators, current source bias circuits, single-ended and fully differential CMOS OP amps, and switch capacitor filters. Through various assignments, students enhance their ability to design analog circuits, perform hand analysis, and simulate circuits.

SEMI542/GSST513 Chip-to-chip IO design ······ (3-0-3)

Chip-to-chip I/O circuits enable electrical communication between different chips using voltage or current signals. In this course, students will learn circuit design techniques for various chip-to-chip I/O interfaces, covering package parasitics, channels, transmitters, receivers, and clock synchronization. They will independently study research papers and conduct design projects using simulation tools. Students will present their findings and project results through assignments.

SEMI561 Advanced Semiconductor Processes ······ (3-0-3)

To understand semiconductor device fabrication, students undergo an in-depth study of key theories such as gas kinetics and vacuum science, as well as the five major representative processes required for device fabrication: photolithography, etching, metallization, cleaning, and Chemical Vapor Deposition (CVD). Advanced learning of these processes commonly used in Integrated Device Manufacture (IDM) or Foundry operations provides, students with insight into the challenges in the next-generation semiconductor device integration process and potential directions for further advancement.

SEMI562 Thin Film Process Technology ······ (3-0-3)

This advanced course focuses on the deposition process in semiconductor fabrication. It covers the differences between thin film and bulk materials, surface reactions that occur during the deposition and etching processes, and particularly emphasizes understanding of vacuum and plasma, which are crucial technologies in these processes. Students will learn about the relationship between surface energy and crystal structure, principles and limitations of surface analysis techniques, vacuum and vacuum devices, and fundamental concepts of plasma. They will also study the characteristics of deposition processes such as Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), and Atomic Layer Deposition (ALD). Additionally, various case studies will be explored to understand the differences in properties based on different deposition methods, ultimately connecting this knowledge to the understanding of integration processes.

SEMI621/GSST623/QIST655 Topological Material Information Devices ······························ (3-0-3)

This lecture focuses on basic understanding of the topological properties of materials and discusses the applications of information devices and topological quantum computers based on topological materials. To achieve this, we first study basic quantum mechanics and methods for calculating the band structure of materials, and discuss the topological properties of wave functions. Next, we study about the topological properties of two-dimensional semiconductor materials and graphene, and under stand the theoretical descriptions of topological systems such as topological insulators, topological superconductors, and the quantum Hall effect. Based on this knowledge, we further explore the recent device applications through reviewing information devices based on the topological quantum materials, and the implementation of topological quantum computers.

SEMI641/EECE667 Circuit Analysis Algorithms and Software ··· (3-0-3)

Prerequisite Courses: Digital System Design, Ultra-Large-Scale Integrated Circuit System Design

The objective of this course is to provide background knowledge on computer techniques and algorithms in the field of ultra-large-scale integrated circuit analysis and design, aiming to enhance the design capabilities of circuit designers. The course begins with an introduction to the current state of design automation, covering various computer algorithms, numerical analysis techniques, and graphic theories related to the analysis and design of ultra-large-scale integrated circuits. Both theory and applications are covered, and students are encouraged to gain software development experience through project work.

SEMI690A/Z Advanced Topics in Semiconductor Eng. ··············· (Variable Credit, Up to 3 Credits)

This course involves selecting a title not specified in the curriculum and inviting a visiting professor or full-time professor to deliver lectures on a subject of interest according to the latest trends.

SEMI699 Master Thesis Research ·· (Variable Credit)

Thesis Research for Master's Degree

SEMI701 Semiconductor Engineering Seminar ·· (1-0-1)

This course invites experts from various fields to provide the fundamental knowledge required for interdisciplinary scientific and technological research.

SEMI899 Doctoral Dissertation Research ·· (Variable Credit)

Thesis Research for Doctoral Degree

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.

[Credits Required for Graduation]

- Until 2022 students enrolled

Program	Course Credits	Research Credits	Total Credits
Master Program	18	10	28
Ph.D Program	12	20	32
M.S.-Ph.D. Integrated Program	24	36	60

- Starting in 2023

Program	Course Credits	Research Credits	Total Credits
Master Program	18	10	28
Ph.D Program	15	17	32
M.S.-Ph.D. Integrated Program	27	33	60

All DESE student should take three or more Environmental core subjects to acquire of basic environmental knowledge.

- Environmental core subjects

No.	Number of Subject	Name of Subject
1	EVSE510	Introduction to Environmental Engineering
2	EVSE520	Air Pollution
3	EVSE525	Water Pollution
4	EVSE540	Environmental Biotechnology
5	EVSE575	Global Environment
6	EVSE579	Environmental Statistics
7	EVSE581	Environmental Physical Chemistry
8	EVSE583	Environmental Inorganic Chemistry
9	EVSE584	Geophysical Fluid Dynamics
10	EVSE587	Environmental Organic Chemistry
11	EVSE588	Climate Physics
12	EVSE591	Environmental Risk Assessment
13	EVSE593	Introduction to Big Data for Environment

* Subjects can be changed depend on situation

- For All DESE Student

Considering the rapid growth and diversity of the environmental field, DESE offers various courses and introduces On-site Process Study and Independent Projects. To promote research capabilities, students in the Master's Program must attend seminars twice, students in the Doctoral Program must attend seminars three times, and students in the Integrative Program must attend seminars five times.

- 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 ‘A0’ 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

[Undergraduate course credits]

Division	Until 2018 students enrolled	Starting in 2019
Undergraduate Courses (Maximum 6 credits)	400units (G or S/U)	200 ~ 400units (G or S/U)

[All graduate students are required to take Scientific Writing for Graduate Students (GEDU501)]

- **Completion of this courses is required for graduation but not included in credit needed to graduate.**
- **After and including the 2023 academic year number**

[All graduate students are required to take Research Ethics (ICEC501]

- **Completion of this courses is required for graduation but not included in credit needed to graduate.**
- **After and including the 2023 academic year number**

3. Course List

Category	Course No.	Title	lec-lab.-cr.
Basic elective (Undergraduate)	EVSE100	Introduction to Environmental Science & Engineering	1-0-1
	EVSE101	Introduction to Environmental Science	3-0-3
Major Elective	EVSE501	Introduction to Environmental Studies	3-0-3
	EVSE510	Introduction to Environmental Engineering	3-0-3
	EVSE520	Air Pollution	3-0-3
	EVSE525	Water Pollution	3-0-3
	EVSE535	Waste Management	3-0-3
	EVSE540/IBIO665	Environmental Biotechnology	3-0-3
	EVSE550	Environmental Engineering Laboratory	1-6-3
	EVSE565	Reaction Engineering	3-0-3
	EVSE575	Global Environment	3-0-3
	EVSE579/MATH538	Environmental Statistics	3-0-3
	EVSE580/IBBT622K	Polymers and the Environment	3-0-3
	EVSE581	Environmental Physical Chemistry	3-0-3
	EVSE582	Introduction to Climate Change	3-0-3
	EVSE583	Environmental Inorganic Chemistry	3-0-3
	EVSE584	Geophysical Fluid Dynamics	3-0-3
	EVSE585	Basic Principles in Environmental Materials	3-0-3
	EVSE586	Environmental Nanoporous Materials	3-0-3
	EVSE587	Environmental Organic Chemistry	3-0-3
	EVSE588	Climate Physics	3-0-3
	EVSE589	cean-Atmosphere Interaction	3-0-3
	EVSE590/NUCE546	Bioremediation Engineering	3-0-3
	EVSE591	Environmental Risk Assessment	3-0-3
	EVSE592	Hydroclimatology	3-0-3
	EVSE593	Introduction to Big Data for Environment	3-0-3
	EVSE594	Environmental Electrochemistry	3-0-3
	EVSE621	Wastewater Treatment Engineering	3-0-3
	EVSE655	Mass Spectrometry	3-0-3
	EVSE661	Environmental Instrument Analysis and Experiments	1-6-3
	EVSE665	Mass Spectrometry	3-0-3
	EVSE667	Pollutant Analysis	3-0-3
	EVSE680 A-Z	Special Topics in Environmental Engineering A-Z	credits varies
	EVSE681/MEIE655/ WEGS587	Environmental Renewable Energy	3-0-3
	EVSE695	On-site Process Study	2-2-3
	EVSE711A-D	Advanced Environmental Processes A-D	3-0-3
	EVSE720	Photocatalysis for Energy and Environmental Applications	3-0-3
	EVSE725	Environmental Bioprocess Engineering	3-0-3
	EVSE730/CHEB738	Introduction of Marine Environments and Biotechnology	3-0-3
Research	EVSE599	Seminar	1-0-1
	EVSE699	Master Thesis Research	1~9
	EVSE899	Doctoral Dissertation Research	1~9
	EVSE795	Independent Project	0-6-3

4. Major Field Courses Listed by Category

<table>
<tr><th colspan="3">Classification</th><th>Category</th><th>Course Title</th><th>Remarks</th></tr>
<tr><td rowspan="11">Univ.</td><td colspan="2" rowspan="11">Common Subject</td><td rowspan="2">Require-ment</td><td>Scientific Writing for Graduate Students</td><td rowspan="2">(disapproval of granting a credit); included in graduation requirements from year 2023</td></tr>
<tr><td>Research Ethics</td></tr>
<tr><td rowspan="9">Free Elective</td><td>Research Paper Presentation Skills</td><td rowspan="9"></td></tr>
<tr><td>Current Trends in Chemistry</td></tr>
<tr><td>Electrochemistry for Energy Application</td></tr>
<tr><td>Applied Numerical Methods</td></tr>
<tr><td>Transducer Theory and Its Applications</td></tr>
<tr><td>Acoustics</td></tr>
<tr><td>Advanced Thermodynamics</td></tr>
<tr><td>A Study on Interplays of Humanities and Technology</td></tr>
<tr><td>Convergence Imagination & Design Thinking of Engineering</td></tr>
<tr><td rowspan="38">Dept.</td><td colspan="2" rowspan="13">Core Elective</td><td rowspan="13">Major Elective</td><td>Introduction to Environmental Engineering</td><td rowspan="13">Completion of at least three of the environmental core subjects during the master's and doctorate courses</td></tr>
<tr><td>Air Pollution</td></tr>
<tr><td>Water Pollution</td></tr>
<tr><td>Environmental Biotechnology</td></tr>
<tr><td>Global Environment</td></tr>
<tr><td>Environmental Statistics</td></tr>
<tr><td>Environmental Physical Chemistry</td></tr>
<tr><td>Environmental Inorganic Chemistry</td></tr>
<tr><td>Earth Environmental Fluid Dynamics</td></tr>
<tr><td>Environmental Organic Chemistry</td></tr>
<tr><td>Climate Physics</td></tr>
<tr><td>Environmental Risk Assessment</td></tr>
<tr><td>Introduction to Big Data for Environment</td></tr>
<tr><td rowspan="25">Field</td><td rowspan="12">Water-quality and waste</td><td rowspan="12">Major Elective</td><td>Introduction to Environmental Engineering</td><td rowspan="12"></td></tr>
<tr><td>Water Pollution</td></tr>
<tr><td>Waste Management</td></tr>
<tr><td>Environmental Biotechnology</td></tr>
<tr><td>Environmental Engineering Laboratory</td></tr>
<tr><td>Basic Principles in Environmental Materials</td></tr>
<tr><td>Environmental Organic Chemistry</td></tr>
<tr><td>Wastewater Treatment Engineering</td></tr>
<tr><td>Environmental Renewable Energy</td></tr>
<tr><td>On-site Process Study(Project)</td></tr>
<tr><td>Environmental Bioprocess Engineering</td></tr>
<tr><td>Environmental Electrochemistry</td></tr>
<tr><td rowspan="7">Ecological Environment</td><td rowspan="7">Major Elective</td><td>Global Environment</td><td rowspan="7"></td></tr>
<tr><td>Polymers and Environment</td></tr>
<tr><td>Environmental Organic Chemistry</td></tr>
<tr><td>Bioremediation Engineering</td></tr>
<tr><td>Environmental Renewable Energy</td></tr>
<tr><td>Ocean Biochemical Cycle</td></tr>
<tr><td>Introduction of Marine Environments and Biotechnology</td></tr>
</table>

Classification			Category	Course Title	Remarks
Dept.	Field	Air Pollution	Major Elective	Introduction to Environmental Engineering	
				Air Pollution	
				Environmental Physical Chemistry	
				Environmental Inorganic Chemistry	
				Environmental Nanoporous Materials	
		Climate Change	Major Elective	Global Environment	
				Introduction to Climate Change	
				Geophysical Fluid Dynamics	
				Climate Physics	
				Ocean-Atmosphere Interaction	
				Hydroclimatology	
				Introduction to Big Data for Environment	
				Environmental Renewable Energy	
		Common Elective	Major Elective	Introduction to Environmental Studies	
				Reaction Engineering	
				Environmental Statistics	
				Environmental Instrument Analysis and Experiments	
				Mass Spectrometry	
				Pollutant Analysis	
				On-site Process Study(Project)	
				Special Topics in Environmental Engineering A-Z	
				Advanced Environmental Process A-D	
				Photocatalysis for Energy and Environmental Application	
Dept.	Interdisciplinary Elective		Major Elective	Subjects opened in other departments and graduate schools	Maximum of 6 credits for each division
	Bachelor's degree program		Basic Elective	Introduction to Environmental Science & Engineering	Undergraduates only
				Introduction to Environmental Science	
	Others		Research subject	Master Thesis Research	1-9
				Doctoral Dissertation Research	
				Independent Project	
				Seminar	A time of study: master 2, doctorate 3, integrated 5

5. Departmental Curriculum Roadmap

Major	Category		Course Title
Dept.	Common Course (Requirement)		Scientific Writing for Graduate Students, Research Ethics
	Common Course (Free Electives)		Research Paper Presentation Skill, Current Trends in Chemistry, Electrochem. for Energy Application, Applied Numerical Methods, Transducer Theory & Its Applications, Advanced Thermodynamics, Acoustics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering
	Core Elective		Introduction to Environmental Engineering, Air Pollution, Water Pollution, Environmental Biotechnology, Gloval Environment, Environmental Statistics, Environmental Physical Chemistry, Environmental Inorganic Chemistry, Geophysical Fluid Dynamics, Environmental Organic Chemistry, Climate Physics, Environmental Risk Assessment, Introduction to Big Data for Environment
	Field	Water-quality and waste	Introduction to Environmental Engineering, Water Pollution, Waste Management, Environmental Biotechnology, Environmental Engineering Laboratory, Basic Principles in Environmental Materials, Environmental Organic Chemistry, Wastewater Treatment Engineering, Environmental Renewable Energy, On-site Process Study(Project), Environmental Bioprocess Engineering, Environmental Electrochemistry
		Ecological Environment	Global Environment, Polymers and Environment, Environmental Organic Chemistry, Bioremediation Engineering, Environmental Risk Assessment, Ocean Bioeochemical Cycle, Introduction of Marine Environments and Biotechnology
		Air Pollution	Introduction to Environmental Engineering, Air Pollution, Environmental Physical Chemistry, Environmental Inorganic Chemistry, Environmental Nanoporous Materials
		Climate Change	Global Environment, Introduction to Climate Change, Geophysical Fluid Dynamics, Climate Physics, Ocean-Atmosphere Interaction, Hydroclimatology, Introduction to Big Data for Environment, Environmental Renewable Energy
		Common Elective	Introduction to Environmental Studies, Reaction Engineering, Environmental Statistics, Environmental Instrument Analysis and Experiments, Mass Spectrometry, Pollutant Analysis, On-site Process Study(Project), Special Topics in Environmental Engineering A-Z), Advanced Environmental Process A-D, Photocatalysis for Energy and Environmental Application
	Interdisciplinary Elective		Subjects opened in other departments and graduate schools (6 credits)

6. Course Description

EVSE100 Introduction to Environmental Science & Engineering ··· (1-0-1)

Provide basic knowledge of graduate environmental research programs to undergraduate students who are interested in environmental research by introducing how research in science and engineering that solves environmental problems are being conducted in the laboratory.

EVSE101 Introduction to Environmental Science ········ **(3-0-3)**

Understand the scientific basis of environmental-energy-climate change, identify recent issues on global environmental changes and environmental problems, and acquire the need for multidisciplinary research to solve them.

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)**

This course covers the emission sources and the formation and deposition processes of air pollution. This course also discusses ground and satellite monitoring, exposure assessment, health effect studies, and air quality management in relation to air pollution.

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 Geophysical 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.

EVSE588 Climate Physics ······ (3-0-3)

This course aims at understanding basics of the physical interaction processes in the climate system from a global perspective, focusing on atmospheric radiative transfer, surface energy balance, and hydrological cycle. Responses in climate system components under global warming are discussed through students' presentations.

EVSE589 Ocean-Atmosphere Interaction ······ (3-0-3)

Introduce various interactions between the atmosphere and the ocean, and understand the associated dynamical processes. Understand roles of ocean-atmospheric interactions in various climate phenomena and future climate change.

EVSE590 Bioemediation Engineering ······ (3-0-3)

The course covers re-mediation of contaminated soil and ground water focusing on biological methods (bio-re-mediation). Theoretical background of various bio-re-mediation technologies are introduced by using case studies.

EVSE591 Environmental Risk Assessment ······ (3-0-3)

The purpose of this course is to learn the past and current procedures of Environmental Impact Assessment and Ecological Risk Assessment and to apply both procedures to students' own research topic to engage in the drafting process.

EVSE592 Hydroclimatology ······ (3-0-3)

In a changing climate, the water cycle within the Earth climate system is expectedly changed. This course will provide an interdisciplinary learning experience across the disciplines of climatology and hydrology to better understand the major components of the water cycle and their changes in a changing climate. In addition, this course includes an independent term project using their data and methods from relevant literature reviews.

EVSE593 Introduction to Big Data for Environment ······ (3-0-3)

The course covers introduction of big data for environment and advanced statistical techniques. The course includes a term project that design a solution to environmental issues using big data-based AI techniques.

EVSE594 Environmental Electrochemistry (3-0-3)

The purpose of this course is to provide foundational knowledge for designing electrochemical processes and systems for environmental remediation and energy conversion, through an understanding of 1) electrochemical reactions and their principles, 2) electrochemical catalysts, 3) electrochemical analysis techniques, and 4) their applications in environmental and energy engineering.

EVSE599 Seminar (1-0-1)

Invited speakers who are working on a variety of environment-related issues in academia, industry, and government give special lectures on specialized subjects.

EVSE621 Wastewater Treatment Engineering (3-0-3)

This class focus on various sources, characteristics, and typical processes for wastewater treatment. Concepts and application of physical and biological processes are discussed.

EVSE655 Ocean Bioeochemical Cycle (3-0-3)

This course primarily covers chemical and biological processes influencing the fate of pollutants within the ocean. Of those pollutants, it primarily covers the behavior of anthropogenic CO2 in the oceans.

EVSE661 Environmental Instrument Analysis and Experiments (1-6-3)

Introduction to various chemical instrumental analysis: basic principles and applications (MS, ICP, AA, GC, HPLC, Gas Analyzer etc.).

EVSE665 Mass Spectrometry (3-0-3)

Further understanding of the mass spectrometry principle. The application, data analysis, and operation system of mass spectrometry.

EVSE667 Pollutant Analysis (3-0-3)

Practical sampling, concentration, separation of the environmental sample. Optimal selection of the analytical method and comprehensive analytical systems for various organic and inorganic compounds.

EVSE680 Special Topics in Environmental Engineering A-Z (credits varies)

Special topics in environment-related issues that are not covered by regular courses can be offered through this course when needed.

EVSE681 Environmental Renewable Energy (3-0-3)

Scientific theories and applications of solar energy, wind power, biomass, and bioenergy are introduced.

EVSE695 On-site Process Study (2-2-3)

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 marin 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)**

ICEC501 Research Ethics ······ **(1-0-1)**

A research ethics course for responsible research of POSTECH graduate students. This course covers the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community.

GEDU501 Scientific Writing for Graduate Students ······ **(3-0-2)**

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified.
Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill ······ **(3-0-2)**

The course will focus on professional presentations for international conferences.
Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers.
The instruction process will offer individual practicums for the delivery of presentations at international conferences.

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.

AMSE513 Electrochemistry for Energy Applications ······ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical methods ······ (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.

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.

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.

CHEB621 Advanced Thermodynamics ······ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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]

Programs	Course Credit	Research Credit	Overall Credit
M.S	18	10	28
Ph.D	15	17	32
Integrative	30	30	60

[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. Cross-listed courses can be recognized as majors, only if completed with a letter grade.
4. You must take at least 3 credits for the GSAI major elective course for the master's courses and 12 credits or more for the integrated course.
5. The Ph.D. program must be completed with at least nine credits in the GSAI required major or major elective subjects.

6. 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. (Excluded from Graduation Requirements)
7. ICEC501(Research Ethics)
   - Before the 2022 academic year number: BK21 participating students must take the course and it is not included in the graduation credits.
   - After and including the 2023 academic year number: Must take courses and it is not included in the graduation credits.
   - If you completed ICEC501 during a master's course, you do not need to retake this course.
8. TA Duties: Master(4H), Doctoral(8H), Integrated(12H)

3. Program Overview

Area	Course No.	Title	lec-lab.-cr
Essential Major	AIGS515/CSED515	Machine learning	3-0-3
	AIGS537	Artificial Intelligence and Data Science	3-0-3
	AIGS538	Deep learning	3-0-3
Select Major	AIGS500/CSED500	Advanced Linear Algebra for CSE	3-0-3
	AIGS501/CSED501	Transformation Theory	3-0-3
	AIGS502/CSED502	Theory of Computation	3-0-3
	AIGS503/CSED503	Advanced Computer Architecture	3-0-3
	AIGS504/CSED504	Advanced Operating System	3-0-3
	AIGS505/CSED505	Network Performance Analysis	3-0-3
	AIGS506/CSED506	Digital Logic Testing	3-0-3
	AIGS507/CSED507	Software Engineering	3-0-3
	AIGS508/CSED508	Discrete and Computational Geometry	3-0-3
	AIGS509/CSED509	Computer Animation	3-0-3
	AIGS510/CSED510	Implementation and acceleration for machine learning	3-0-3
	AIGS511/CSED511	Introduction to Virtual Reality	3-0-3
	AIGS513/CSED513	Simulation	3-0-3
	AIGS514/CSED514	Pattern Recognition	3-0-3
	AIGS518/CSED518	Linguistics Basis for Natural Language Processing	3-0-3
	AIGS520/CSED519	3D Model Reconstruction	3-0-3
	AIGS521/CSED521	Fuzzy and Intelligent	3-0-3
	AIGS523/CSED523	Statistical Natural Language	3-0-3
	AIGS524/CSED524	Processing Probabilistic Graphical Models	3-0-3
	AIGS526/CSED526	Data Mining	3-0-3
	AIGS527/CSED527	Systems Introduction to Haptics	3-0-3
	AIGS530/CSED530	Advanced Probability Theory for CSE	3-0-3
	AIGS531/MATH530	Mathematical Statistics	3-0-3
	AIGS532/MATH532	Applications of Mathematics and Big Data	3-0-3
	AIGS536/CSED536	Advanced Algorithms	3-0-3
	AIGS539	Computer vision	3-0-3
	AIGS540	Big Data Processing	3-0-3
	AIGS551/CSED551	Computational Photography	3-0-3
	AIGS570	Artificial Intelligence Tech Startup	3-0-3

Area	Course No.	Title	lec-lab.-cr
Select Major	AIGS571	Business AI	3-0-3
	AIGS572	AI+X Solution Studio A	2-2-3
	AIGS573	AI+X Solution Studio B	2-2-3
	AIGS574/IMEN574	Programming for Data Science	3-0-3
	AIGS600/CSED600	Distributed Processing	3-0-3
	AIGS601/CSED601	Dependable Computing	3-0-3
	AIGS602/CSED602	Advanced Database	3-0-3
	AIGS603/CSED603	Parallel Algorithm	3-0-3
	AIGS604/CSED604	Parallel Processing	3-0-3
	AIGS605/CSED605	Real-time Systems	3-0-3
	AIGS607/CSED607	Network Management Systems	3-0-3
	AIGS608/CSED608	Advanced Computer Networks	3-0-3
	AIGS609/CSED609	Applications of Random Variable and Process in Computer Engineering	3-0-3
	AIGS610/CSED610	Information Retrieval	3-0-3
	AIGS611/CSED611	Machine Translation Human	3-0-3
	AIGS613/CSED613	Formal Specification Techniques	3-0-3
	AIGS615/CSED615	Advanced topics in Virtual Reality	3-0-3
	AIGS616/CSED616	Language Technology	3-0-3
	AIGS617/CSED617	Advanced Haptics	3-0-3
	AIGS618/CSED618	Trustworthy Machine Learning	3-0-3
	AIGS620/CSED620	Mobile Networks	3-0-3
	AIGS621/CSED621	Vision and Language	3-0-3
	AIGS626/CSED626	Multimedia Networking	3-0-3
	AIGS627	Reinforcement Learning	3-0-3
	AIGS700A-Z	Topics in Computer Science A-Z	3-0-3
	AIGS701A-Z	Topics in Computation Theory A-Z	3-0-3
	AIGS702A-Z	Topics in Computer Systems A-Z	3-0-3
	AIGS703A-Z	Topics in Artificial Intelligence A-Z	3-0-3
Research Subject	AIGS699	Master Thesis Research	1-9
	AIGS800A/B	Artificial Intelligence Colloquium A/B	1-0-1
	AIGS801	Individual Study	1-9
	AIGS899	Doctoral Dissertation Research	1-9
Common Courses (Free Elective)	ICEC501	Research Ethics	1-0-1
	GEDU501	Scientific Writing for Graduate Students	3-0-2
	GEDU502	Research Paper Presentation Skill	3-0-2
	CHEM500	Current Trends in Chemistry	3-0-3
	AMSE513	Electrochemistry for Energy Application	3-0-3
	MECH505	Applied Numerical Methods	3-0-3
	MECH526	Theory and Applications of Electromechanical Energy Conversion	3-1-3
	MECH531	Acoustics	3-0-3
	CHEB621	Advanced Thermodynamics	3-0-3
	CITE611	A Study on Interplays of Humanities and Technology	3-0-3
	CITE612	Convergence Imagination & Design Thinking of Eng.	3-0-3
	EVSE510	Introduction to Environmental Engineering	3-0-3

4. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Courses		Common Requirement	Research Ethics	Mandatory Requirements: After and including the 2023 academic year (Excluded from Graduation Requirements)
			Free Elective	Scientific Writing for Graduate Students	S/U Evaluation, Excluded from Graduation Requirements
			Free Elective	Research Paper Presentation Skills	
			Free Elective	Current Trends in Chemistry	
			Free Elective	Electrochemistry for Energy Application	
			Free Elective	Applied Numerical Methods	
			Free Elective	Theory and Applications of Electromechanical Energy Conversion	
			Free Elective	Acoustics	
			Free Elective	Advanced Thermodynamics	
			Free Elective	A Study on Interplays of Humanities and Technology	
			Free Elective	Convergence Imagination & Design Thinking of Engineering	
			Free Elective	Introduction to Environmental Engineering	
Dept.	Core Requirements		Major Requirement	Machine Learning	
			Major Requirement	Artificial Intelligence and Data Science	
			Major Requirement	Deep Learning	
			Research Requirement	Artificial Intelligence Colloquium A/B	S/U Evaluation, Excluded from Graduation Requirements
	Core Electives (by Major)	Media AI	Major Elective	Computer Animation	
			Major Elective	Introduction to Virtual Reality	
			Major Elective	Linguistics Basis for Natural Language Processing	
			Major Elective	3D Model Reconstruction	
			Major Elective	Statistical Natural Language	
			Major Elective	Systems Introduction to Haptics	
			Major Elective	Computer Vision	
			Major Elective	Computational Photography	
			Major Elective	Machine Translation Human	
			Major Elective	Advanced Topics in Virtual Reality	
			Major Elective	Language Technology	
			Major Elective	Advanced Haptics	
			Major Elective	Vision and Language	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	Data AI	Major Elective	Data Mining	
			Major Elective	Implementation and Acceleration for Machine Learning	
			Major Elective	Advanced Computer Architecture	
			Major Elective	Applications of Mathematics and Big Data	
			Major Elective	Big Data Processing	
			Major Elective	Information Retrieval	
			Major Elective	Advanced Operating System	
			Major Elective	Advanced Database	
			Major Elective	Software Engineering	
			Major Elective	Programming for Data Science	
		AI Theory	Major Elective	Parallel Processing	
			Major Elective	Distributed Processing	
			Major Elective	Advanced Linear Algebra for CSE	
			Major Elective	Transformation Theory	
			Major Elective	Theory of Computation	
			Major Elective	Digital Logic Testing	
			Major Elective	Discrete and Computational Geometry	
			Major Elective	Simulation	
			Major Elective	Pattern Recognition	
			Major Elective	Fuzzy and Intelligent	
			Major Elective	Processing Probabilistic Graphical Models	
			Major Elective	Advanced Probability Theory for CSE	
			Major Elective	Mathematical Statistics	
			Major Elective	Advanced Algorithms	
			Major Elective	Parallel Algorithm	
			Major Elective	Applications of Random Variable and Process in Computer Engineering	
			Major Elective	Formal Specification Techniques	
			Major Elective	Reinforcement Learning	

<table>
<tr><th colspan="2">Classification</th><th>Category</th><th>Course Title</th><th>Remarks</th></tr>
<tr><td rowspan="11">Dept.</td><td rowspan="10">Common Subjects</td><td>Major Elective</td><td>Artificial Intelligence Tech Startup</td><td></td></tr>
<tr><td>Major Elective</td><td>Business AI</td><td></td></tr>
<tr><td>Major Elective</td><td>AI+X Solution Studio A/B</td><td></td></tr>
<tr><td>Major Elective</td><td>Topics in Artificial Intelligence A-Z</td><td></td></tr>
<tr><td>Major Elective</td><td>Topics in Computation Theory A-Z</td><td></td></tr>
<tr><td>Major Elective</td><td>Topics in Computer Science A-Z</td><td></td></tr>
<tr><td>Major Elective</td><td>Topics in Computer Systems A-Z</td><td></td></tr>
<tr><td>Research Elective</td><td>Master Thesis Research</td><td rowspan="3">S/U Evaluation</td></tr>
<tr><td>Research Elective</td><td>Individual Study</td></tr>
<tr><td>Research Elective</td><td>Doctoral Dissertation Research</td></tr>
<tr><td>Interdisciplinary Electives</td><td>Major Elective</td><td>Courses offered by relevant departments (undergraduate and graduate)</td><td>Up to 6 credits of undergraduate courses are allowed</td></tr>
</table>

5. Departmental Curriculum Roadmap

<table>
<tr><th>Major</th><th>Category</th><th>Course Title</th></tr>
<tr><td rowspan="6">Media AI</td><td>Common Course (Requirement)</td><td>Research Ethics</td></tr>
<tr><td>Common Course (Free Electives)</td><td>Scientific Writing for Graduate Students, Research Paper Presentation Skill, Current Trends in Chemistry, Electrochem. for Energy Application, Applied Numerical Methods, Transducer Theory & Its Applications, Advanced Thermodynamics, Acoustics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering</td></tr>
<tr><td>Dept. Core Requirements</td><td>Machine learning, Artificial Intelligence and Data Science, Deep Learning, Artificial Intelligence Colloquium A/B</td></tr>
<tr><td>Major Electives by Major</td><td>Computer Vision, Computational Photography, Computational Imaging, 3D Model Reconstruction, Computer Animation, Introduction to Virtual Reality, Linguistics Basis for Natural Language Processing, Statistical Natural Language, Machine Translation Human, Language Technology, Systems Introduction to Haptics, Advanced Haptics, Advanced Topics in Virtual Reality, Vision and Language......</td></tr>
<tr><td>Dept. Common Courses</td><td>Artificial Intelligence Tech Startup, Business AI, AI+X Solution Studio A/B, Topics in Artificial Intelligence A-Z, Topics in Computation Theory A-Z, Topics in Computer Science A-Z, Topics in Computer Systems A-Z, Master Thesis Research, Individual Study, Doctoral Dissertation Research</td></tr>
<tr><td>Interdisciplinary Electives</td><td>Courses offered by relevant departments (undergraduate and graduate)</td></tr>
</table>

Major	Category	Course Title
Data AI	Common Course (Requirement)	Research Ethics
	Common Course (Free Electives)	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Current Trends in Chemistry, Electrochem. for Energy Application, Applied Numerical Methods, Transducer Theory & Its Applications, Advanced Thermodynamics, Acoustics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering
	Dept. Core Requirements	Machine learning, Artificial Intelligence and Data Science, Deep Learning, Artificial Intelligence Colloquium A/B
	Major Electives by Major	Data Mining, Implementation and Acceleration for Machine Learning, Advanced Computer Architecture, Optimizaation for Machine Learning, Trustworthy Machine Learning, Applications of Mathematics and Big Data, Big Data Processing, Advanced Database, Information Retrieval, Advanced Operating System, Programming for Data Science, Software Engineering, Parallel Processing, Distributed Processing......
	Dept. Common Courses	Artificial Intelligence Tech Startup, Business AI, AI+X Solution Studio A/B, Topics in Artificial Intelligence A-Z, Topics in Computation Theory A-Z, Topics in Computer Science A-Z, Topics in Computer Systems A-Z, Master Thesis Research, Individual Study, Doctoral Dissertation Research
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)
AI Theory	Common Course (Requirement)	Research Ethics
	Common Course (Free Electives)	Scientific Writing for Graduate Students, Research Paper Presentation Skill, Current Trends in Chemistry, Electrochem. for Energy Application, Applied Numerical Methods, Transducer Theory & Its Applications, Advanced Thermodynamics, Acoustics, A Study on Interplays of Humanities and Technology, Convergence Imagination & Design Thinking of Engineering, Introduction to Environmental Engineering
	Dept. Core Requirements	Machine Learning, Artificial Intelligence and Data Science, Deep Learning, Artificial Intelligence Colloquium A/B
	Major Electives by Major	Theory of Computation, Advanced Algorithms, Parallel Algorithm, Reinforcement Learning, Simulation, Advanced Linear Algebra for CSE, Transformation Theory, Processing Probabilistic Graphical Models, Digital Logic Testing, Discrete and Computational Geometry, Fuzzy and Intelligent, Pattern Recognition, Advanced Probability Theory for CSE, Mathematical Statistics, Applications of Random Variable and Process in Computer Engineering, Formal Specification Techniques
	Dept. Common Courses	Artificial Intelligence Tech Startup, Business AI, AI+X Solution Studio A/B, Topics in Artificial Intelligence A-Z, Topics in Computation Theory A-Z, Topics in Computer Science A-Z, Topics in Computer Systems A-Z, Master Thesis Research, Individual Study, Doctoral Dissertation Research
	Interdisciplinary Electives	Courses offered by relevant departments (undergraduate and graduate)

6. Course Description

AIGS500/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, Positive Definite Matrices, etc.

AIGS501/CSED501 Transformation Theory······························ **(3-0-3)**

In this course, students will study varous linear transformations in both continous and discrete time domain, and their relationship. the course is a study of how to apply these transformations to a variety of applications in computer science and engineering.

AIGS502/CSED502 Theory of Computation······························ **(3-0-3)**

Recommended Prerequisites : CSED341 (Automata and Formal Languages)

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

AIGS503/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.

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.

AIGS510/CSED510 Implementation and Acceleration for Machine Learning······························ (3-0-3)

Deep learning applications are actively used in various types of applications. The amount of computation required for inference and training is increasing rapidly, and at the same time, the demand for deploying these applications on mobile devices is also increasing. Deep learning optimization is becoming more and more important. In this course, we will learn advanced optimization techniques from the perspective of both hardware and software. By learning various studies about how to optimize deep learning algorithms, we could acquire knowledge that will be helpful in future research.

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

Statistcs)

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.

AIGS520/CSED19 3D Model Reconstruction ······························ (3-0-3)

This course covers various aspects and approaches of 3D model reconstruction. 3D geometry reconstruction methods could be categorized based on the input data types and output representations. The basic idea and representative approaches will be discussed for each category. Color and material reconstructions topics will be handled as well. As human would be a popular target of 3D modeling, human body and face reconstruction will also be covered in the course.

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.

AIGS528/CSED528 Optimization for Machine Learning ························ (3-0-3)

Optimization is a foundational concept in machine learning. It underpins the process of model training and performance improvement driving the success of modern artificial intelligence. This course provides theoretical foundations and in-depth understanding of optimization techniques used in machine learning. Students will learn the principles of convex optimization including convex sets, functions, and duality theory as well as practical algorithms for solving optimization problems in machine learning ranging from first-order to second-order methods, and to stochastic, large-scale, distributed methods. It is a fundamental course for anyone interested in optimization theory and its applications to machine learning..

AIGS529/CSED520 Computational Imaging ······ (3-0-3)

Computational imaging has fueled the rapid developments of many application systems, including mobile phones, autonomous vehicles, VR/AR devices, consumer electronics, robots, microscopes, and telescopes. This course discusses essential concepts and critical applications of computational imaging. Specifically, we focus on digital photography, AI techniques for computational imaging, optics, human perception, inverse problems in computational imaging. Students will implement each concrete example in Python. Students will learn the cutting-edge research in computational imaging.

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 ········ (3-0-3)

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 ········ (3-0-3)

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 ········ (3-0-3)

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.

AIGS570 Artificial Intelligence Tech Startup ········ (3-0-3)

This course aims to develop ablilities to build your own business model by implementing ideas, various methodologies for business adminstration and technologies. Through the entrepreneurship class based on Kauffman Foundation's PEV program and the metoring program with a venture capitalist, students will experience the whole procedure of starting venture including market abalysis, business model design, developing service/technology roadmap, marketing/financial strategies

AIGS571 Business AI ········ (3-0-3)

This course introduces the trend of technology based startups (especially digital transformation) and analyzes the frameworks and cases of AI technology commercialization and application. By studying the application of various AI technologies in real industrial sites and applying the datas and algorithms, students will get a chance to find appropriate technology

AIGS572/AIGS573 AI+X Solution Studio A/B ········ (2-2-3)

This course is designed as an 1 year (2 semester) course. In AI+X Solution Studio A course, students will start with ideation by creative design thinking workshop, feasibility analysis, and developing prototpyes. The AI+X Sloution Studio B course is a capstone design course and aims to develop solutions and demonstrate the results in the demo day.

AIGS574/IMEN574 Programming for Data Science ·················· **(3-0-3)**

Recommended 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 wangling, visualization, supervised and unsupervised learning, professional ethics are discussed in class.

AIGS600/CSED600 Distributed Processing ·················· **(3-0-3)**

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 ·················· **(3-0-3)**

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 ·· (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.

AIGS611/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.

AIGS613/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.

AIGS615/CSED615 Advanced topics in Virtual Reality······································ (3-0-3)

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··· (3-0-3)

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 mutli-modal systems.

AIGS617/CSED617 Advanced Haptics·· (3-0-3)

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.

AIGS618/CSED618 Trustworthy Machine Learning·· (3-0-3)

As machine learning and deep learning models are impacting on real world environments, concerns on the trustworthiness of machine-learned models are rising. In this course, we explore whether popular machine-learned models are trustworthy and then study various learning methods to enchant the models to be trustworthy. To this end, we will learn basic knowledge on machine learning theory, uncertainty learning via conformal prediction, adversarial examples/learning, machine unlearning, differentially private learning, fairness in learning, miscellaneous topics on trustworthy generative AI.

AIGS620/CSED620 Mobile Networks··· (3-0-3)

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.

AIGS621/CSED621 Vision and Language ··· (3-0-3)

Recommended Prerequisites : CSED538 (Deep Learning), CSED539(Computer Vision)

This course will explore topics between two active research areas in AI: Computer Vision (CV) & Natural Language Processing (NLP). As pictures and words are often naturally linked on the internet and in the real world, vision and language can reinforce information by aiding each other. For CV, text associated with images/videos and knowledge learned from language allows to better understand image. For NLP, images/videos help ground language in the physical world and develop better models for semantics. In this course, we will learn how to make use of the complementary nature of vision and language through topic lectures, presentation, and discussions about state-of-the-art research.

AIGS626/CSED626 Multimedia Networking ··· (3-0-3)

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 ··· (3-0-3)

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 ··· (1-9)

A research course for Master's thesis.

AIGS700A-Z Topics in Computer Science A-Z ··· (3-0-3)

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

AIGS701A-Z Topics in Computation Theory A-Z ··· (3-0-3)

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

AIGS702A-Z Topics in Computer Systems A-Z ··· (3-0-3)

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

AIGS703A-Z Topics in Artificial Intelligence A-Z ··· (3-0-3)

This course covers advanced topics in artificial intelligence research.

AIGS800A/B Artificial Intelligence Colloquium A/B ··· (1-0-1)

AIGS801 Individual Study ··· (1-9)

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 ··· (1-9)

A research course for Ph. D. thesis.

ICEC501 Research Ethics ························ (1-0-1)

A research ethics course for responsible research of POSTECH graduate students. This course covers the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community.

GEDU501 Scientific Writing for Graduate Students ························ (3-0-2)

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified.
Active discussion is encouraged to promote the participation of students.

GEDU502 Research Paper Presentation Skill ························ (3-0-2)

The course will focus on professional presentations for international conferences.
Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers.
The instruction process will offer individual practicums for the delivery of presentations at international conferences.

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.

AMSE513 Electrochemistry for Energy Applications ························ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical methods ························ (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.

MECH526 Theory and Applications of Electromechanical Energy Conversion ························ (3-1-3)

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

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

MECH531 Acoustics ······ (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.

CHEB621 Advanced Thermodynamics ······ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

Division of Advanced Nuclear Engineering

1. Education Aim

DANE aims to be the leader in the further development of safe and sustainable nuclear energy by preparing leading specialists with integrity, creativity and innovative quality in nuclear engineering through providing high-quality education and training in the platform of education and research. DANE also aims to collaborate with national and global experts and research and education institutes to perform top- notch research through the combination of fundamental science such as physics, chemistry, material and geological science and applying technologies such as nuclear, mechanical, chemical, bio, and environmental engineering.

As nuclear engineering is a multidisciplinary field engaged in science, technology and engineering, it incorporates diverse research areas with vanguard technologies to achieve both efficiency and safety of nuclear power plants (NPPs). With the goal to be the leader in the further development of safe and sustainable nuclear energy, DANE offers the education and research programs in (a) nuclear safety and energy conversion, (b) nuclear physics and plasma, and (c) radioactive waste management. The comprehensive graduate program covering the three broad areas requires multi-disciplinary collaborations including nuclear and plasma physics, mechanical, chemical and environmental engineering, and materials and geological science.

2. Graduation Requirements and Procedures

[Course Requirements]

A. Courses Curriculum(Applies to students enrolled since the spring semester of 2021)

Category	Course Title	Remarks
Common Mandatory Courses	Nuclear Engineering	
	Nuclear Reactor Physics	
	Nuclear Power and Social Problems	
Common Elective Courses	Radiation Detection	*At least 3 credits has to be obtained
	Nuclear Reactor Experiment	
	Introduction of Advanced Nuclear Convergence for Future Society	
Required Courses	Nuclear Thermal-Hydraulics	Nuclear Safety
	Plasma and Beam Physics	Plasma and Accelerator
	Radioactive Waste Management, Introduction to Nuclear Materials Engineering	Nuclear Environment and Material
	Intro. to AI and Robotics for Extreme Environment, Field Robotics	AI and Robot System

Category	Course Title	Remarks
Elective Courses	Nuclear Power Plant Engineering, Two Phase Flow, Heat Transfer Physics, Nuclear Safety and Regulation, Intro. Nuclear Safety & Related Laws, SP:VR Technologies and their applications	Nuclear Safety
	Nuclear Fusion Plasmas, Principles & Tech. on the Accelerators, Intro. to Sync.radiation&its sci. opp., Rad. Shielding&Monte Carlo Simulation, Numerical Simul. for Plasma Sci. & Eng., Plasma Physics I/II, SP:Frontier X-ray Science	Plasma and Accelerator
	Chemical Treatment of Waste and Disposal, Adv. of Radioactive Waste Mgnt., Radioactive Contami. in the Env., Noncrystalline Ceramics, Nuclear Fuel Cycle Engineering	Nuclear Environment and Material
	Basic Practice for Nuclear Eng-AI, Machine Learning for Nuc. Engineering, AI based Robotics and Perception for Hazardous and Extreme Environment's Tasks, Tutor General-Purpose Engineer Tool	AI and Robot System
Social Convergence Courses	Capstone Design Project for Social Problems, Social Problem&Hazardous Robotics, Science & Technology Policy, Adv. Artificial Intelligence for M.E., Artificial intelligence and Ethics, Statistical Ressearch Method	*At least 3 credits has to be obtained
Research Courses	Seminar	NUCE800
	Master Thesis Research	NUCE69901-09
	Doctoral Dissertation Research	NUCE89901-09
Common Subjects Courses	Scientific Writing for Graduate Students	GEDU501
	Research Paper Presentation Skill	GEDU502
	Research Ethics(Required course, after 2023)	ICEC501

B. Required 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)

  Students who continuing their studies for the Ph.D course after receiving master's degree from POSTECH's DANE are exempted from taking duplicate courses if they have completed all required major courses during the master's course.

- **The students who have been enrolled since the spring semester of 2017**

  Students are required to take 2 of the 3 required 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.

  For students continuing their studies for a doctoral degree after receiving a master's degree from

POSTECH's DANE, major required courses shall be waived if they were all taken during the master's program.

- **Students enrolled from 2021**

  Students are required to take 3 Common required Courses(Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems).

  Students are required to take 1 of the 6 required Courses(Nuclear Thermal-Hydraulics, Plasma and Beam Physics, Radioactive Waste Management, Intro. to AI and Robotics for Extreme Environment, Introduction to Nuclear Materials Engineering, Field Robotics).

  Student who continuing their studies for the Ph.D course after receiving M.S degree from POSTEH's DANE are exempted without taking duplicate courses if they have completed common subjects(required, elective), compulsory major, and social convergence subjects.

C. Elective Courses

- **Students enrolled prior to 2021**

  Students must complete minimum two NUCE elective courses for the completion of the degree.
- **Students enrolled from 2021**

  Students are required to take more than 3 credits of the Common Elective Courses.

  Students are required to take more than 3 credits of the Social Convergence Courses.

D. Graduate Student Seminar

- Master Program students should take two or more semesters of the DANE seminar courses.
- M.S.-Ph.D. Integrated Program students should take five or more semesters of the DANE seminar courses are required.
- Ph.D. Program students should take three or more semesters of the DANE seminar courses are required.

E. Common Subjects Courses for graduate student

- Scientific Writing for Graudate Students(GEDU501), Research Paper Presentation Skill(GEDU502) are excluded from graduation credits.
- Research Ethics(ICEC501) is required course(after 2023), it is excluded from graduation credits. (For students with a bachelor's degree in Nuclear Engineering, the requirement to take ICEC501 shall be waived)

[Credit Requirements]

- **Students enrolled prior to 2014**

	Course Credits	Research Credits	Total Credits
Master Program	15	13	28
Ph.D Program	12	20	32
M.S.-Ph.D. Integrated Program	24	36	60

- **Students enrolled from 2014**

	Course Credits	Research Credits	Total Credits
Master Program	18	10	28
Ph.D Program	15	17	32
M.S.-Ph.D. Integrated Program	30	30	60

- Students enrolled from 2021

	Course Credits	Research Credits	Total Credits
Master Program	18	10	28
Ph.D Program	21	11	38
M.S.-Ph.D. Integrated Program	36	24	60

- 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

Ph.D. and M.S.-Ph.D. Integrated Program students should submit a dissertation proposal within four semesters. Students can extend two 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 required 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).
- **Applies to students enrolled since the spring semester of 2021**
  In principle, the Q.E. will be a written examination.
  Students must pass the Q.E. for 3 Common Mandatory Courses(Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems) and must pass the Q.E. for 1 out of 6 Mandatory Courses (Nuclear Thermal-Hydraulics, Plasma and Beam Physics, Radioactive Waste Management, Intro. to AI and Robotics for Extreme Environment, Introduction to Nuclear Materials Engineering, Field Robotics). 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. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing for Graduate Students	*Graduation credits are not counted
			Free Elective	Research Paper Presentation Skill	
			Free Elective	Research Ethics	*Mandatory Requirements: After and including the 2023 academic year *Graduation credits are not counted
Dept.	Common Required Courses		Major Requirement	Nuclear Engineering	
			Major Requirement	Nuclear Reactor Physics	
			Major Requirement	Nuclear Power and Social Problems	
	Common Elective Courses		Major Elective	Radiation Detection	*At least 3 credits has to be obtained
			Major Elective	Nuclear Reactor Experiment	
			Major Elective	Advanced Nuclear Convergence for Future Society	
	Core Electives (by Major)	Nuclear Safety	Major Requirement	Nuclear Thermal-Hydraulics	
			Major Elective	Nuclear Power Plant Engineering	
			Major Elective	Heat Transfer Physics	
			Major Elective	Two Phase Flow	
			Major Elective	Nuclear Safety and Regulation	
			Major Elective	Advances of Nuclear Reactor Physics and Engineering	
			Major Elective	Intro. Nuclear Safety & Related Laws	
			Major Elective	SP:VR Technologies and their applications	
		Plasma and Accelerator	Major Requirement	Plasma and Beam Physics	
			Major Elective	Intro. to Sync.radiation&its sci. opp.	
			Major Elective	Numerical Simul. for Plasma Sci. & Eng.	
			Major Elective	Principles & Tech. on the Accelerators	
			Major Elective	Radiation Prot.&Monte Carlo Analysis	
			Major Elective	Probabilistic Safety Analysis	
			Major Elective	Plasma Physics I/II	
			Major Elective	SP:Frontier X-ray Science	
			Major Elective	Nuclear Fusion Plasmas(Unopened Lecture)	
		Nuclear Environment and Material	Major Requirement	Radioactive Waste Management	
			Major Requirement	Introduction to Nuclear Materials Engineering	
			Major Elective	Radioactive Contami. in the Env.	
			Major Elective	Noncrystalline Ceramics	
			Major Elective	Nuclear Fuel Cycle Engineering	
			Major Elective	Adv. of Radioactive Waste Mgnt.	
			Major Elective	Radiation Safety	
			Major Elective	Radiochemistry	
			Major Elective	Chemical Treatment of Waste and Disposal(Unopened Lecture)	

Classification			Category	Course Title	Remarks
Dept.	Core Electives (by Major)	AI and Robot System	Major Requirement	Fundamental of Robotics & A.I.	
			Major Requirement	Field Robotics	
			Major Elective	Basic Practice for Nuclear Eng-AI	
			Major Elective	Machine Learning for Nuc.Engineering	
			Major Elective	Tutor General-Purpose Engineer Tool	
			Major Elective	AI based Robotics and Perception for Hazardous and Extreme Environment's Tasks(Unopened Lecture)	
	Social Convergence Courses		Major Elective	Nuclear & Capst. Design of Soc. Prob.	*At least 3 credits has to be obtained
			Major Elective	Statistical Research Method	
			Major Elective	Social Problem&Hazardous Robotics	
			Major Elective	Artificial Intelligence for M.E.	
			Major Elective	Science & Technology Policy/ Artificial intelligence and Ethics(Unopened Lecture)	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate) *Master Program : Up to six credits are accepted. *Ph.D. and M.S.-Ph.D. Integrated Program : Up to 12 credits are accepted.	*6 Credits of undergratuate courses(400 level) are allowed

4. Departmental Curriculum Roadmap

Major	Category	Course Title
Nuclear Safety	Common Required Courses	Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems
	Common Elective Courses	Radiation Detection, Nuclear Reactor Experiment, Advanced Nuclear Convergence for Future Society
	Major Requirement	Nuclear Thermal-Hydraulics
	Major Elective	Nuclear Power Plant Engineering, Heat Transfer Physics, Two Phase Flow, Nuclear Safety and Regulatio, Advances of Nuclear Reactor Physics and Engineering, Intro. Nuclear Safety & Related Laws, SP:VR Technologies and their applications
	Social Convergence Courses	Nuclear & Capst. Design of Soc. Prob., Statistical Research Method, Social Problem&Hazardous Robotics, Artificial Intelligence for M.E., Science & Technology Policy/ Artificial intelligence and Ethics(Unopened Lecture)
	(UNIV) Common Subjects	Research Ethics
Plasma and Accelerator	Common Required Courses	Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems
	Common Elective Courses	Radiation Detection, Nuclear Reactor Experiment, Advanced Nuclear Convergence for Future Society
	Major Requirement	Plasma and Beam Physics
	Major Elective	Intro. to Sync.radiation&its sci. opp., Numerical Simul. for Plasma Sci. & Eng., Principles & Tech. on the Accelerators, Radiation Prot.&Monte Carlo Analysis, Probabilistic Safety Analysis, Plasma Physics I/II, Nuclear Fusion Plasmas(Unopened Lecture), SP:Frontier X-ray Science
	Social Convergence Courses	Nuclear & Capst. Design of Soc. Prob., Statistical Research Method, Social Problem&Hazardous Robotics, Artificial Intelligence for M.E., Science & Technology Policy/ Artificial intelligence and Ethics(Unopened Lecture)

Major	Category	Course Title
Nuclear Environment and Material	Common Required Courses	Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems
	Common Elective Courses	Radiation Detection, Nuclear Reactor Experiment, Advanced Nuclear Convergence for Future Society
	Major Requirement	Radioactive Waste Management, Introduction to Nuclear Materials Engineering
	Major Elective	Radioactive Contami. in the Env., Noncrystalline Ceramics, Adv. of Radioactive Waste Mgnt., Radiation Safety, Radiochemistry, Nuclear Fuel Cycle Engineering, Chemical Treatment of Waste and Disposal(Unopened Lecture)
	Social Convergence Courses	Nuclear & Capst. Design of Soc. Prob., Statistical Research Method, Social Problem&Hazardous Robotics, Artificial Intelligence for M.E., Science & Technology Policy/ Artificial intelligence and Ethics(Unopened Lecture)
	(UNIV) Common Subjects	Research Ethics
AI and Robot System	Common Required Courses	Nuclear Engineering, Nuclear Reactor Physics, Nuclear Power and Social Problems
	Common Elective Courses	Radiation Detection, Nuclear Reactor Experiment, Advanced Nuclear Convergence for Future Society
	Major Requirement	Fundamental of Robotics & A.I., Field Robotics
	Major Elective	Basic Practice for Nuclear Eng-AI, Machine Learning for Nuc.Engineering, Tutor General-Purpose Engineer Tool, AI based Robotics and Perception for Hazardous and Extreme Environment´s Tasks(Unopened Lecture)
	Social Convergence Courses	Nuclear & Capst. Design of Soc. Prob., Statistical Research Method, Social Problem&Hazardous Robotics, Artificial Intelligence for M.E., Science & Technology Policy/ Artificial intelligence and Ethics(Unopened Lecture)
	(UNIV) Common Subjects	Research Ethics

5. Course Description

NUCE501 Nulcear 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.

NUCE503 Nuclear Power & Social Problems ···························· (3-0-3)

This course deals with systematic analysis of social issues and their implications. For the analysis, data produced through various channels are extracted, processed, and analyzed. The course focuses on the changes in social issues and discusses the basis for those changes through data analysis.

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.

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).

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.

NUCE523 Plasma and Beam Physics ········· (3-0-3)

The basic physics of weakly ionized plasmas will be taught based on the single particle, fluid, and kinetic theory of interacting charged particles and neutrals. The emphasis will be given on the physics parameters relevant to atmospheric pressure plasmas. Practical problems will be examined such as gas breakdown, plasma diagnostics, and biomedical and industrial applications of atmospheric plasmas.

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.

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.

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.

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.

NUCE608/609 Plasma Physics I, II······························ **(3-0-3)**

Various phenomena of charged particles in the electrromagnetic 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.

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.

NUCE699 Master Thesis Research······························ **(1~9, credits varies)**

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

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.

NUCE711 Probabilistic Safety Analysis······························ (3-0-3)

Basic Concepts of Risk and Nuclear Safety, The Nature of Nuclear Power Plant Accidents, Nuclear Power Plant Safety Systems, Risk Assessment Methodology 1. Event Tree and Fault Tree, 2. Level 1, 2, and 3 PSA, 3. External PSA, Reliability Analysis and Major Nuclear Core Melt Down Accidents.

NUCE718A-Z Special Topics in Advanced Nuclear Engineering·············· (credits varies)

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

NUCE718I Numerical Simul. for Plasma Science. & Engineering·············· (3-0-3)

Introduction to a set of basic computing skills for studying common science and engineering problems: Mathematical modeling as ODE, PDE, initial-value or boundary-value problems. Kinetic modeling based on particle-in-cell/Monte-Carlo methods. Development of computer simulation hierarchy (model equations, geometry/domains, boundary conditions, mesh, solving, post-processing, etc.) using high-level tools such as matlab, COMSOL, mathematica, and femlab.

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.

NUCE718R Nuclear Thermal-Hydraulics······························ (3-0-3)

This lecture covers the process of energy generation and transport from the core of a nuclear reactor to the thermal design and safety analysis of such as a core.

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.

NUCE718T Basic Practice for Nuclear Engineering-AI······························ (1-2-3)

This class aims at achieving a basic ability to conduct convergence researches of the nuclear engineering and artificial intelligence (AI). From this class, the application ability of AI into the field of nuclear engineering is developed.

NUCE718U Nuclear Safety and Regulatio)·· (3-0-3)

Focus on Licensee's responsibilities and Regulator's various policies and tools to meet the safety goals set by the law. In detail, the concept of nuclear safety regulation, various safety regulatory review and inspection programs, safety culture, nuclear accidents and follow-up activities, safety of nuclear power plant and fuel cycle facilities, safe management of spent fuel and radioactive waste, radiation protection and safe use of radioactive material, environmental radioactivity monitoring and prevention of radiation disaster, nuclear security and non-proliferation, etc.

NUCE718W Social Problem & 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.

NUCE718X Machine Learning for Nuc. Engineering···(1-2-3)

This class aims at achieving a basic ability to conduct convergence researches of the nuclear engineering and artificial intelligence (AI). From this class, the application ability of AI into the field of nuclear engineering is developed.

NUCE718Y Tutor General-Purpose Engineer Tool·· (1-4-3)

Focusing on practical training education, the emphasis is placed on acquiring the fundamental skills of essential computational tools in various fields, including nuclear thermal-hydraulics, plasma physics, and robotics. Through a practical training education approach, students will learn how to effectively use multi-physics analysis software employed in nuclear thermal-hydraulics and plasma field. And students will improve their proficiency in basic program commonly used in robotics.

NUCE719A-Z Special Topics in Advanced Nuclear Engineering································ (credits varies)

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

NUCE719B Introduction Nuclear Safety & Related Laws··(3-0-3)

Nuclear Utilization, Nuclear Safety Concept, Safety Regulatory Systen, Safety Design and Facilities, Severe Accident Management, Severe NPP case study, Safety culture, Nuclear Fuel Cycle and Spent Fuel, Radioactive Waste Management, Radioactive Safety, NPP life extension, NPP Dismantlement, Radiation safety, etc

NUCE719C Advances Nuclear Convergence **for Future Social··(3-0-3)**

The course provides the introduction of 5 focused-areas ('Nuclear safety', 'Nuclear Environment', 'Plasma & Accelerator', 'Robotics & AI', 'Humanities & Social science') in the Division of Advanced Nuclear Engineering for advanced nuclear convergence for future society. Students are expected to learn actual practices based on well-defined case problems in each area.

NUCE719D Nuclear Power and Capstone Design of Social Problems································ (3-0-3)

This course, by analyzing key social areas, derives social issues that require further analyses in each social area. For scientific and systematic research on such issues, students will learn a series of statistical and social data concerning the social issues, and methods of data extraction, cleansing, and preprocessing. In addition, students examining the statistical and social data will understand the social topography in South Korea, and they will discuss changing patterns and implications from the analyses according to each social issue. Through this, students will acquire the ability to logically organize their thoughts, and the capability to analyze social issues and their changes at both macro and micro levels. At the same time, students will recognize the importance and validity of "Evidence-Based Arguments".

NUCE719E Fundamental of Robotics & A.I. ························ **(3-0-3)**

The goal of the class is to understand the fundamental of the robot system and AI for practical Nuclear Engineering related applications. The class focuses on the system-level fundamental understanding of the robot and AI rather than a specific field. This course introduces most robot and AI fields and critical elements such as sensing, control, intelligence, and recognition for beginners in an easy explanation. Various examples of robots, AI, and actual implementation techniques will be studied. The class includes theoretical and practical aspects of the topic.

NUCE719F Statistical Ressearch Method ························ **(3-0-3)**

The course covers the statistical methodology necessary for social science research. Specifically, it deals with multivariate normal distribution, variance analysis, repeated measurement data analysis, principal component analysis, factor analysis, regression analysis, discriminant analysis, and logistic regression.

NUCE719I Introduction to Nuclear Materials Engineering ························ **(3-0-3)**

Nuclear Materials Engineering is one of the three essential components of nuclear engineering, aiming to cultivate the ability to creatively develop and predict the property changes of materials used in nuclear systems, and to train nuclear engineers who can respond to industrial demands. Starting with the introduction of the characteristics of reactor materials, it plans to introduce the basic material's crystal structure and crystal defects, material thermodynamics, deformation and strengthening of materials, fracture/fatigue/creep damage of materials, radiation defect generation and radiation damage mechanism, nuclear fuel, radiation damage of reactor vessels and internal structures. In particular, it discusses in detail the development and production of nuclear fuel, thermal changes and heat transfer performance, in-service corrosion phenomena and the characteristics of spent nuclear fuel. It provides students with the opportunity to directly use the SRIM/TRIM open code to calculate radiation damage and provide the opportunity to simulate the radiation damage of specific materials. Finally, it plans to conduct a practical case study on the development and production of nuclear fuel and structural materials being discussed in small modular reactors, molten salt reactors, high-temperature helium fast reactors, lead/lead-bismuth fast reactors, sodium fast reactors, etc., which are under development as next-generation reactors at domestic and international.

NUCE719H Field Robotics ························ **(2-2-3)**

Robotics is a course that educates on the fundamental qualities of robots operating in special industrial environments such as radioactive areas, underwater, high temperatures, and inside intakes. It focuses on the primary functions of field robots, especially core theories related to mobility and task execution, and provides a broad range of examples of field/mobile robots in various terrains, including land, sea, and air. Additionally, the course covers practical training on ROS (Robotic Operation System), a Linux-based robot development tool, including the basics of ROS, robot simulation through the visualization tool Gazebo, sensor modeling, and the entire process of designing, manufacturing, and operating field/mobility robots based on ROS.

NUCE719J Nuclear Fuel Cycle Engineering ·· (3-0-3)

Nuclear Fuel Cycle Engineering covers the entire nuclear fuel cycle, which involves mining uranium to produce nuclear fuel needed for nuclear power generation, processing into the form of nuclear fuel, efficiently burning in a nuclear power plant, and transporting, processing, and disposing of high-level radioactive waste. In particular, it examines various engineering cases at domestic and international that are necessary for safe management of spent nuclear fuel, such as intermediate storage and transportation, reprocessing, and permanent disposal. It plans to introduce the issues of in-house storage and pool storage of spent nuclear fuel, long-distance transportation, transport canister technology and dry storage technology for large-capacity storage, reprocessing and recycling, and development of deep disposal containers. It specifically examines the development of a standardization system for spent nuclear fuel management, thermal safety/structural safety/containment integrity verification tests, land/sea transport scenarios and accident safety evaluation technology. Finally, it discusses the disposal policy of spent nuclear fuel overseas, and plans to conduct a practical case study on the production of nuclear fuel and the disposal of spent nuclear fuel in small modular reactors, molten salt reactors, high-temperature helium fast reactors, lead/lead-bismuth fast reactors, sodium fast reactors, etc., which are under development as next-generation reactors. The class plans to have the opportunity to visit Korea Nuclear Fuel or domestic radioactive waste management facilities.

NUCE719M Special Topic: Frontier X-ray Science ·· (3-0-3)

Through this lecture, we will seek for gaining basic understanding of the synchrotron X-ray radiation, and want to explore its scientific applications for structure characterizations by introducing various experimental techniques to include crystal diffraction, small angle scattering, coherent imaging, spectroscopy, etc..

NUCE719R Special Topic:VR Technologies and their applications ··· (3-0-3)

Students can (1) develop the fundamental understanding of virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR) technologies, (2) learn VR contents coding technique, and (3) via team projects for VR contents production from an initial design to final demonstration, they can deepen the knowledge of VR technologies, and VR contents coding capabilities. After completion of the lecture, participants may be able to explain the structure and working mechanism of VR headsets, and also apply the VR contents production skills to various fields such as their research presentations or personal contents creation.

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.

NUCE731 Advances of Radioactive Waste Management ········ **(3-0-3)**

This course provides the graduate (or senior) students for advanced understanding of radiochemistry, radionuclide speciation, aqueous geochemistry and modeling, mineralogy, groundwater hydrology, low-temperature solid waste form development, geomicrobiology, mechanisms of microbial transformations of actinides, fission and activation products, the impacts of microbial activity on disposal of low-level wastes in shallow land burial grounds, intermediate-level waste in engineered facilities, and high-level waste in deep geological formations, microbial gas generation from radioactive wastes, environmental contamination and remediation methods, bioremediation of contaminated sites, vitrification of radioactive wastes, and decontamination methods and technology development.

NUCE732 Radiochemistry ········ **(3-0-3)**

This radiochemistry course is designed for graduate students in the nuclear engineering or other engineering departments, and the chemistry department, who are beginning their careers in radiochemistry. The objective of this course is to introduce the theories and fundamental understanding of radiochemistry. Topics to be covered the nuclear stability, including the fundamental principle of radioactive(alpha-, beta-, and gamma-) decay, the interaction of radiation with the matters, and their measurements through alpha/gamma spectrometry, and gross alpha/gross beta counting. In addition to the protection from the exposure of radioactivity dealing in the laboratory. furthermore, the usage of radioactive tracers in chemical kinetics, the separation chemistry, and the environmental chemistry will be also covered in the course. Each student from this course will be able to work effectively with nuclear engineers and the environmental radio-chemist in the nuclear industry or the academic institutes.

NUCE800 Seminar ········ **(1-0-1)**

Weekly seminars are organized throughout a semester. Prominent speakers whose work related with various fields of nuclear engineering and physics are invited for the seminar.

NUCE899 Doctoral Dissertation Research ········ **(1~9, credits varies)**

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

[Univ-Common Subjects]

GEDU501 Scientific Writing for Graduate Students ········ **(3-0-2)**

This course is to enhance the understanding of the organization, sentence structures and unique features of science and technology journal papers, and to use them for actual journal paper writing.
To this end, published papers are analyzed and their characteristics are identified.
Active discussion is encouraged to promote the participation of students.

GEDU502 Research paper Presentation Skill ········ **(3-0-2)**

The course will focus on professional presentations for international conferences.

Participants will learn the preparation process, word choice selection, presentation analysis, delivery skills, and anxiety management for a skillful address to an audience of their peers.
The instruction process will offer individual practicums for the delivery of presentations at international conferences.

ICEC501 Research Ethics ······ (1-0-1)

- Research Ethics for responsible research of POSTECH graduate students
- Explain the concepts of research integrity, social responsibility, research data, publication ethics, bioethics, and research community for responsible research.(Mandatory Requirements: After and including the 2023 academic year, Graduation credits are not counted)

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.

AMSE513 Electrochemistry for Energy Applications ······ (3-0-3)

This course covers the fundamentals of electrochemistry for materials science and engineering including some important practical applications in energy research area. The lecture begins with an overview of electrode processes showing the way in which the fundamental components of the subject come together in an electrochemical experiment. Then, basic concepts of electrochemistry will be covered such as thermodynamics and potential, electron-transfer kinetics, and mass transfer. The basic concepts are integrated together in treatments of the various practical electrochemical methodologies. Finally, a few important applications of electrochemistry in materials science and engineering discipline will be briefly introduced such as batteries, fuel cells, water electrolysis, corrosion/anti-corrosion and electroplating.

MECH505 Applied Numerical Methods ······ (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 scientific and 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 in engineering practice.

MECH526 Theory and Applications of Electromechanical Energy Conversion ······ (3-1-3)

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

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

MECH531 Acoustics ························ (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.

CHEB621 Advanced Thermodynamics ························ (3-0-3)

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

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 familiarized with creative and critical imagination beyond traditional disciplinary boundaries. It is also anticipated that students will be leading figures in bringing 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.

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.

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.

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.

M.S. Program(28 credits)		Ph.D. Program(35 credits)		M.S-Ph.D. Integrated Program (60 credits)	
Course	Research	Course	Research	Course	Research
15	13	15	20	24	36

In the case of doctoral programs and integrated courses, students must complete at least 6 credits of required major courses.

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

Category	Area	Course No.	Title	Lec.-Lab.-Crd
Major Requirements	Materials Chemistry	ADMS502/CHEM531	Inorganic Materials Chemistry	3-0-3
		ADMS503/CHEM552	Organic Materials Chemistry	3-0-3
		ADMS508/CHEM521	Advanced Organic Chemistry	3-0-3
		ADMS509/CHEM561	Advanced Chemical Biology	3-0-3
		ADMS510/CHEM510	Quantum Chemistry	3-0-3
		ADMS515/CHEM551	Synthesis & Characterization of Macromolecules	3-0-3
		ADMS518/CHEM541	Advanced Analytical Chemistry	3-0-3
		ADMS613/CHEM613	Statistical Thermodynamics	3-0-3
	Materials Physics	ADMS504/PHYS505	Quantum Mechanics I	3-0-3
		ADMS505/PHYS503	Electrodynamics I	3-0-3
	Device Materials	ADMS506/PHYS401	Solid State Physics	3-0-3
		ADMS557/AMSE681	Physical Properties of Opto-Electronic Materials	3-0-3
Major Electives	Materials Chemistry	ADMS510/CHEM510	Quantum Chemistry	3-0-3
		ADMS511/CHEM632	Supramolecular Chemistry	3-0-3
		ADMS513	Materials Chemistry	3-0-3
		ADMS514	Spectrometric Identification of Materials	3-0-3

Category	Area	Course No.	Title	Lec.-Lab.-Crd
Major Electives	Materials Chemistry	ADMS517/CHEM619	Nanochemistry	3-0-3
		ADMS519/CHEM535	Physical Methods in Inorganic Chemistry	3-0-3
		ADMS520/CHEM451	Macromolecular Chemistry	3-0-3
		ADMS521	Energy Nanomaterials	3-0-3
		ADMS522/CHEM542	Analytical Spectroscopy	3-0-3
		ADMS710	Special Topics in Materials Chemistry	3-0-3
		ADMS712/CHEM736	Homogeneous Catalysis	3-0-3
		ADMS713/CHEM741	Applied Electrochemistry	3-0-3
		ADMS714/CHEM754	Physical Properties of Macromolecular Solutions	3-0-3
		ADMS715/CHEM755	Speciality Macromolecules	3-0-3
		ADMS744A-D	Special Topics in Polymer Physics	1-3
	Materials Physics	ADMS531/PHYS501	Analytical Mechanics	3-0-3
		ADMS532/PHYS504	Electrodynamics Ⅱ	3-0-3
		ADMS533/PHYS506	Quantum Mechanics Ⅱ	3-0-3
		ADMS534/PHYS601	Quantum Mechanics Ⅲ	3-0-3
		ADMS535/PHYS513	Advanced Statistical Mechanics	3-0-3
		ADMS536/PHYS521	Solid State Physics Ⅰ	3-0-3
		ADMS537/PHYS522	Solid State Physics Ⅱ	3-0-3
		ADMS538/PHYS652	Vacuum Physics & Technology	3-0-3
		ADMS621	Condensed Matter Field Theory	3-0-3
		ADMS720	Special Topics in Materials Physics	3-0-3
		ADMS721/PHYS701	Special Topics in Condensed Matter I	3-0-3
		ADMS722/PHYS702	Special Topics in Condensed Matter II	3-0-3
		ADMS723/PHYS703	Special Topics in Condensed Matter III	3-0-3
		ADMS724/PHYS705	Special Topics in Modern Physics I	3-0-3
		ADMS725/PHYS706	Special Topics in Modern Physics II	3-0-3
	Device Materials	ADMS507/AMSE501	Advanced Thermodynamics of Materials	3-0-3
		ADMS555/AMSE648	Structure of Thin Films	3-0-3
		ADMS556/AMSE650	Piezoelectric/Ferroelectric Materials	3-0-3
		ADMS558/AMSE645	Optical Properties of Materials	3-0-3
		ADMS561/AMSE684	Nanoscale Semiconductor Devices	3-0-3
		ADMS562/AMSE686	Electrical Properties of Low Dimensional Materials	3-0-3
		ADMS563/AMSE682	Surface Analysis and Nano-scale Characterizations	3-0-3

Category	Area	Course No.	Title	Lec.-Lab.-Crd
Major Electives	Device Materials	ADMS566/AMSE683	Light Emitting Diodes	3-0-3
		ADMS567	Advanced Materials in Nanotechnology	3-0-3
		ADMS568/AMSE669	Nano-Biomaterials	3-0-3
		ADMS570/AMSE649	Photonics Glasses	3-0-3
		ADMS601/AMSE606	Statistical Mechanics of Materials	3-0-3
		ADMS740	Special Topics in Device Materials	3-0-3
		ADMS741/AMSE742	Special Topics in Electronic Materials	3-0-3
		ADMS743/AMSE741	Special Topics in Ceramics	3-0-3
	Common Subjects	ADMS501	Nanoscience	3-0-3
		ADMS590/TIMP685	Patent & Information Analysis	2-0-2
		ADMS599	Current Trends in Materials Science	3-0-3
Research		ADMS699	Master Thesis Research	1-9
		ADMS800	AMS Literature Seminar	1-0-1
		ADMS801	Colloquium	1-0-1
		ADMS899	Doctoral Dissertation Research	1-9

*ADMS801 Colloquium Alternative Recognized Subjects
- CHEM 809 Colloquium, PHYS801 Colloquium, AMSE701 Seminars in Materials Science

4. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Electives	Scientific Writing	
				Scientific Presentation	
Division of Advanced Matierials Science	Compulsory (per realm)	Materials Chemistry	Major Compulsory	Inorganic Materials Chemistry	
		Materials Physics		Organic Materials Chemistry	
		Device Materials		Quantum Mechanics I	
				Electrodynamics I	
				Solid State Physics	
				Physical Properties of Opto-Electronic Materials	
	Elective (per realm)	Materials Chemistry	Major Elective	Quantum Chemistry	
				Supramolecular Chemistry	
				Materials Chemistry	
				Spectrometric Identification of Materials	
				Synthesis & Characterization of Macromolecules	
				Nanochemistry	
				Advanced Analytical Chemistry	
				Physical Methods in Inorganic Chemistry	
				Macromolecular Chemistry	
				Energy Nanomaterials	

Classification			Category	Course Title	Remarks
Division of Advanced Matierials Science	Elective (per realm)	Materials Chemistry	Major Elective	Analytical Spectroscopy	
				Special Topics in Materials Chemistry	
				Homogeneous Catalysis	
				Applied Electrochemistry	
				Physical Properties of Macromolecular Solutions	
				Speciality Macromolecules	
				Special Topics in Polymer Physics	
		Materials Physics		Analytical Mechanics	
				Electrodynamics Ⅱ	
				Quantum Mechanics Ⅱ	
				Quantum Mechanics Ⅲ	
				Advanced Statistical Mechanics	
				Solid State Physics Ⅰ	
				Solid State Physics Ⅱ	
				Vacuum Physics & Technology	
				Condensed Matter Field Theory	
				Special Topics in Materials Physics	
				Special Topics in Condensed Matter Physics Ⅰ	
				Special Topics in Condensed Matter Physics Ⅱ	
				Special Topics in Condensed Matter Physics Ⅲ	
				Special Topics in Modern Physics Ⅰ	
				Special Topics in Modern Physics Ⅱ	
		Device Materials		Advanced Thermodynamics of Materials	
				Structure of Thin Films	
				Piezoelectric/Ferroelectric Materials	
				Optical Properties of Materials	
				Nanoscale Semiconductor Devices	
				Electrical Properties of Low Dimensional Materials	
				Surface Analysis and Nano-scale Characterizations	
				Light Emitting Diodes	
				Advanced Materials in Nanotechnology	
				Nano-Biomaterials	
				Photonics Glasses	
				Statistical Mechanics of Materials	
				Special Topics in Device Materials	
				Special Topics in Electronic Materials	
				Special Topics in Ceramics	
		Common		Nanoscience	
				Patent & Information Analysis	
				Current Trends in Materials Science	
	Interdisciplinary Electives			Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

5. Departmental Curriculum Roadmap

Major	Category		Course Title
Division of Advanced Matierials Science	Common Course		Sceintific Writing, Scientific Presentation
	Compulsory (per realm)	Materials Chemistry	Inorganic Materials Chemistry, Organic Materials Chemistry
		Materials Physics	Quantum Mechanics Ⅰ, Electrodynamics Ⅰ
		Device Materials	Solid State Physics, Physical Properties of Opto-Electronic Materials
	Elective (per realm)	Materials Chemistry	Quantum Chemistry, Supramolecular Chemistry, Materials Chemistry, Spectrometric Identification of Materials, Synthesis & Characterization of Macromolecules, Nanochemistry, Advanced Analytical Chemistry, Physical Methods in Inorganic Chemistry, Macromolecular Chemistry, Energy Nanomaterials, Analytical Spectroscopy, Special Topics in Materials Chemistry, Homogeneous Catalysis, Applied Electrochemistry, Physical Properties of Macromolecular Solutions, Speciality Macromolecules, Special Topics in Polymer Physics
		Materials Physics	Analytical Mechanics, Electrodynamics Ⅱ, Quantum Mechanics Ⅱ, Quantum Mechanics Ⅲ, Advanced Statistical Mechanics, Solid State Physics Ⅰ, Solid State Physics Ⅱ, Vacuum Physics & Technology, Condensed Matter Field Theory, Special Topics in Materials Physics, Special Topics in Condensed Matter Physics Ⅰ, Special Topics in Condensed Matter Physics Ⅱ, Special Topics in Condensed Matter Physics Ⅲ, Special Topics in Modern Physics Ⅰ, Special Topics in Modern Physics Ⅱ
		Device Materials	Advanced Thermodynamics of Materials, Structure of Thin Films, Piezoelectric/Ferroelectric Materials, Optical Properties of Materials, Nanoscale Semiconductor Devices, Electrical Properties of Low Dimensional Materials, Surface Analysis and Nano-scale Characterizations, Light Emitting Diodes, Advanced Materials in Nanotechnology, Nano-Biomaterials, Photonics Glasses, Statistical Mechanics of Materials, Special Topics in Device Materials, Special Topics in Electronic Materials, Special Topics in Ceramics
	Common Electives		Nanoscience, Patent & Information Analysis, Current Trends in Materials Science
	Interdisciplinary Electives		Subjects offered by relevant departments undergraduate and graduate schools

6. 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.

ADMS508/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.

ADMS509/CHEM561 Advanced Chemical Biology ······ **(3-0-3)**

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.

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 fluctuatio-dissipation theorem are covered.

ADMS536,537/PHYS521,522 Solid State Physics Ⅰ, Ⅱ ······························ (3-0-3)

This course discusses at advanced level experimental and theoretical problems in solid state physics. Topics include electromagnetic, optical, thermal and transport properties of solids, energy band theory and Fermi surface, magnetism, and superconductivity.

ADMS538/PHYS652 Vacuum Physics & Technology······························ (3-0-3)

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

ADMS555/PHYS648 Structure of Thin Films ······························ (3-0-3)

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

ADMS556/AMSE650 Piezoelectric/Ferroelectric Materials······························ (3-0-3)

This course introduces various interesting modern topics in ferroelectric systems. These include crystal structure, statistical thermodynamic and Landau's phenomenological descriptions of ferroelectric phase transitions, lattice dynamics and Raman scattering, domain structure, relaxor 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/AMSE684 Nanoscale Semiconductor Devices······························ (3-0-3)

The topics related to the fabrication of nano-scale devices are provided. Main topics include basic semiconductor device processing including thin films deposition and lithographic techniques as well as contemporary processing issues including ALD, gate stack. contact. interconnect. Also nano-technology based processing including nano-patterning and nano-material synthesis will be covered.

ADMS562/AMSE686 Electrical Properties of Low Dimensional Materials ········· (3-0-3)

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

ADMS563/AMSE682 Surface Analysis and Nano-scale Characterizations ········· (3-0-3)

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

ADMS566/AMSE683 Light Emitting Diodes ········· (3-0-3)

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

ADMS567 Advanced Materials in Nanotechnology ········· (3-0-3)

This class aims to give a general introduction to contemporary subjects in nano-science and nano-technology, with a particular emphasis on solid-state electronics. The lecture is designed for the class (1) to get familiar to modern materials science in nano-technology, (2) to understand the basic physical principles operating at the nanometer scale, and (3) to develop the skill of effective and critical reading of experimental literature.

ADMS568/AMSE669 Nano-Biomaterials ········· (3-0-3)

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

ADMS570/AMSE649 Photonics Glasses ········· (3-0-3)

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

ADMS590/TIMP685 Patent & Information Analysis ········· (2-0-2)

This course aims to provide education for understanding of patents and how to prepare patents.

ADMS599 Current Trends in Materials Science ········· (3-0-3)

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

ADMS601/AMSE606 Statistical Mechanics of Materials ··· (3-0-3)

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

ADMS613/CHEM613 Statistical Thermodynamics ··· (3-0-3)

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

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 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>
<tr><th></th><th colspan="2">MS/PhD Integrated Program</th><th>Doctoral Program</th><th>Master's Program</th></tr>
<tr><td>Research Credits</td><td colspan="2">33</td><td>14</td><td>7</td></tr>
<tr><td>Major Requirement
(3 credits)</td><td colspan="2">Frontiers in Interdisciplinary Bioscience</td><td rowspan="6">18 course credits (required course:6 credits & elective course: 12 credits)</td><td rowspan="6">21 course credits (required course:6 credits & elective course: 15 credits)</td></tr>
<tr><td>Required Electives
(3 or more credits)</td><td colspan="2">Nano-Biomaterials (IBIO514/AMSE669)
Biological Physics (IBIO526/PHYS413)
Advanced Molecular Genetics (IBIO528/LIFE517
BioMEMS (IBIO529/MECH535)
Principles of Biomedical Opt.& Imaging (IBIO530/CITE551)
Integrative Bio-Imaging Technology (IBIO531/IBBT501
Advanced Synthetic Biology (IBIO534/CHEB801H)
Experimental Biophysical Chemistry (IBIO536/IBBT610)
Biofluid Mechanics (IBIO616/MECH624)
Biopolymer Chemistry (IBIO652/LIFE601)
Advanced Metabolic Engineering (IBIO650/CHEB643)
Advanced Molecular Biology Ⅰ (IBIO652/LIFE601)
Biology of Aging (IBIO655/LIFE515)
Tissue Engineering (IBIO657/MECH532)
Advanced Bio-Imaging (IBIO711/PHYS712A</td></tr>
<tr><td rowspan="4">Major Electives
(21 or more credits)</td><td colspan="2">Biology background</td></tr>
<tr><td>Physics/Chem/Math/Computer Science (12 credits)
Biosciences (9 credits)</td><td>Engineering (12 credits)
Biosciences (9 credits)</td></tr>
<tr><td>Physics/Chem/Math/Computer Science background</td><td>Engineering background</td><td></td><td></td></tr>
<tr><td>Physics/Chem/Math/Computer Science (9 credits)
Bioscience (12 credits)</td><td>Engineering (9 credits)
Biosciences (12 credits)</td><td></td><td></td></tr>
<tr><td>TRACKS</td><td>Track Ⅰ
Systems Biosciences</td><td>Track Ⅱ
Systems Bioengineering</td><td></td><td></td></tr>
</table>

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. Major Field Courses Listed by Category

Classification		Category	Course Title	Remarks
Univ.	Common Subjects	Free Electives	Scientific Writing	
			Scientific Presentation	
Interdisciplinary Bioscience and Bioengineering	Core Requirements	Major Requirements	Frontiers in Interdisciplinary Biosciences	
			Method in Interdisciplinary Research	- Doctor's degree/ Integration - 4 times - Master's degree - 2 times
	Core Required Electives	Major Required Electives	Nano-Biomaterials	IBIO514/AMSE669
			Biological Physics	IBIO526/PHYS413
			Advanced Molecular Genetics	IBIO528/LIFE517
			BioMEMS	IBIO529/MECH535
			Principles of Biomedical Opt.& Imaging	IBIO530/CITE551
			Integrative Bio-Imaging Technology	IBIO531/IBBT501
			Special Topics in Chemical Engineering - Advanced Synthetic Biology	IBIO534/CHEB801H
			Experimental Biophysical Chemistry	IBIO536/IBBT610
			Biofluid Mechanics	IBIO616/MECH624
			Biopolymer Chemistry	IBIO621/CHEM652
			Advanced Metabolic Engineering	IBIO650/CHEB643
			Advanced Molecular Biology I	IBIO652/LIFE601
			Biology of Aging	IBIO655/LIFE515
			Tissue Engineering	IBIO657/MECH532
			Advanced Bio-imaging	IBIO711/PHYS712A
	Interdisciplinary Bioscience	Major Electives	Bio-Imaging	IBIO511
			Biostatics	IBIO512
			Information Processing for Genomics and Proteomics	IBIO513
			Introduction to Microfluidics	IBIO515/MECH579
			Advanced Cell Biology	IBIO518/LIFE509
			Digital Image Processing	IBIO519/EECE551
			Machine Learning	IBIO520/CSED515
			Pattern Recognition	IBIO521/CSED514
			System Biology	IBIO522/LIFE414
			Mathematics for Biologists	IBIO523/MATH443
			Personalized Medicine for Engineers	IBIO535/CITE554
			Ultrasonics	IBIO537/CITE555
			Medical Device Design Process	IBIO538/CITE553
			Advanced Biotechnology	IBIO615
			Nanobiotechnology	IBIO617/MECH646
			Bioinformatics	IBIO638/LIFE619
			Biological Molecular Chemistry	IBIO641/CHEM721
	Interdisciplinary Bioengineering	Major Electives	Biomechanics	IBIO647/MECH643
			Bioengineering	IBIO648/MECH647
			Special Topics in Biochemistry	IBIO651/CHEM669
			Transcriptional Regulation for Synthetic Biotechnology	IBIO654/CHEB644
			Advanced Developmental Biology	IBIO656/LIFE508
			Advanced Immunology	IBIO658/LIFE503
			Neurobiology	IBIO659/LIFE505
			Molecular Spectroscopy	IBIO661
			Analytical Spectroscopy	IBIO662/CHEM542
			Biomacromolecular Structures	IBIO663/LIFE611
			Environmental Bio-processing	IBIO665/EVSE540
			Protein Biosynthesis	IBIO667/CHEB645
			Current issues in biological physics	IBIO712/PHYS712B
	Interdisciplinary Electives	Major Electives	Courses offered by relevant departments (undergraduate and graduate schools)	Up to 6 credits of undergraduate courses are allowed

4. Departmental Curriculum Roadmap

Major	Category	Course Title
School of Interdisciplinary Bioscience and Bioengineering	Common Course	Sceintific Writing, Scientific Presentation
	Core Requirements	Frontiers in Interdisciplinary Biosciences, Method in Interdisciplinary Research
	Core Required Electives	Advanced Bio-imaging, Advanced Metabolic Engineering, Advanced Molecular Genetics, Tissue Engineering, Biofluid Mechanics, Nano-Biomaterials, Biopolymer Chemistry, BioMEMS, Biology of Aging, Advanced Molecular Biology I , Principles of Biomedical Opt.& Imaging, Integrative Bio-Imaging Technology, Special Topics in Chemical Engineering - Advanced Synthetic Biology, Biological Physics
	Interdisciplinary Bioscience	Current issues in biological physics, Advanced Cell Biology, System Biology, Bioinformatics, Advanced Developmental Biology, Advanced Immunology, Neurobiology, Biomacromolecular Structures, Mathematics for Biologists, Biological Molecular Chemistry, Special Topics in Biochemistry, Analytical Spectroscopy, Bio-Imaging, Biostatics, Information Processing for Genomics and Proteomics, Advanced Biotechnology, Molecular Spectroscopy
	Interdisciplinary Bioengineering	Introduction to Microfluidics, Nanobiotechnology, Biomechanics, Bioengineering, Transciptional Regulation for Synthetic Biotechnology, Protein Biosynthesis, Einvronmental Bio-processing, Digital Image Processing, Machine Learning, Pattern Recognition, Medical Device Design Process, Personalized Medicine for Engineers, Ultrasonics
Interdisciplinary Electives		Subjects offered by relevant departments undergraduate and graduate schools

5. 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/IBBT610 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, Cohonen Networks and Hop field Network models are analysed. Students study methods of pattern recognition, regression analysis and predictions and various applications.

IBIO521/CSED514 Pattern Recognition ························ (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.

IBIO526/PHYS413 Biological Physics ······ (3-0-3)

This course deals with the basics of Biophysics (Biological Physics/Biophysics) to understand life phenomena by applying physical methods and concepts.
This course introduces biophysical approaches to important life phenomena occurring at the molecular and cellular level, and cultivates the ability to understand life from a physical perspective.

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.

IBIO529/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.

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 micro structure of living organisms. The course also offers in-vivo dynamic research of the micro structure 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.

IBIO536/IBBT610 Experimental Biophysical Chemistry······ (3-0-3)

Teaches basic experimental principles of biochemistry, biology & biophysics to conduct interdisciplinary researches in biology, biological materials, and biotechnology fields

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······ (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.

IBIO616/MECH624 Biofluid Mechanics······ (3-0-3)

This is a basic course with the aim to provide the understanding of the cardio-vascular system.

IBIO617/MECH646 Nanobiotechnology······ (3-0-3)

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······ **(3-0-3)**

The course studies polymers as aone- 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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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······ **(3-0-3)**

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 Bioseparataion Processes ········ (3-0-3)

The course studies technical separation methods of biological macromolecules that take are common in bioengineering applications. It covers basic principles and applications of thermodynamic analysis of diluted solutions, thin membrane filtration chromatography, centrifugal separation and electrophoresis.

IBIO644/CHEB733 Cell Culture Engineering ········ (3-0-3)

The course studies cell cultures, ie, plant and animal cells, mold and algae, and microorganisms such as bacteria from the physical chemistry engineering perspective.

IBIO645/CHEB734 Biochemical Process Engineering ········ (3-0-3)

The course covers basic features of biochemical processes and systematic approaches to analysis, evaluation and optimization of biochemical processes.

IBIO646/CHEB737 Advanced Molecular Biotechnology ········ (3-0-3)

The course introduces basic principles and applications of molecular biology, biochemistry, and microbiology and provides the understanding of molecular biotechnology, based on DNA recombination technology. It delves into the protein recombination manifestation system of bacilli, enzymes, insects, plants and animals as well as applications of molecular biotechnology in the fields of chemistry, medical science, the environment and agriculture.

IBIO647/MECH643 Biomechanics ························ (3-0-3)

Students learn to design models to simulate movements and operations of the human body. This course covers an thropoftry, human body modeling and control theory.

IBIO648/MECH647 Bioengineering ························ (3-1-3)

The course focuses on mechanical and electrical interpretations of the human body. During the course students investigate functions of the limbs and study computational methods for data collection and interpretation.

IBIO649/LIFE622Z Molecular Imaging ························ (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-materials, anatomy, computer-aided design/computer-aided machining (CAD/ CAM), and manufacturing technology. Various mathematical and mechanical tools for simulating cell behavior are introduced. In addition, basic experimental laboratory instruction covers cell culture and scaffold fabrication.

IBIO658/LIFE503 Advanced Immunology ······ (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 Einvronmental Bio-processing ······ (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.

IBIO666/AMSE612 X-ray 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.

IBIO667/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.

IBIO699 Master Thesis Research ······ (1-9)

Students conduct research under the supervision of their academic advisors.

IBIO711/PHYS712A Advanced Bio-imaging ······ (3-0-3)

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 ······ (3-0-3)

We aim to get some sense of current issues in biological physics.

IBIO801A-Z Special Topics in Systems Biology ······ (1-9)

Selected topics reflecting the latest trend in systems biological research will be dealt with in depth.

IBIO811A-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.

IBIO899 Doctoral Dissertation Research ······ (1-9)

Students conduct research under the supervision of their academic advisors

Graduate School of Convergence Science and Technology Program Overview

1. Purpose of Establishment

- Promote world-class convergence education and research grounded in comprehensive interdisciplinary knowledge.
- Cultivate creative professionals with interdisciplinary insight and practical skills, with a focus on advancing core technologies and driving the growth of emerging industries.

2. Program Objectives

- Establish a new graduate program that leads innovation in emerging interdisciplinary fields, bridging the gap between academic disciplines and industry sectors.
- Serve as a hub for fostering interdisciplinary education and research throughout the university.
- Build a robust foundation for interdisciplinary collaboration through integrated support in organizational structure, curriculum development, space allocation, and funding.

3. Academic Program

Program	Overview
Major in Social Data Science	This program aims to cultivate future leaders for a data-driven society by developing an educational model that integrates STEM disciplines with the humanities and social sciences to foster interdisciplinary collaboration.
Major in Medical Science and Engineering	This program is designed for individuals with, or pursuing, a medical license, as well as holders of (or those pursuing) bachelor's or master's degrees in STEM fields. It prepares future leaders in medical science and biomedical engineering through interdisciplinary research that bridges basic science, life sciences, mathematics, and engineering. The program aims to advance human health and contribute to the growth of the biomedical and healthcare industries.
Major in Defense Science and Technology	This program applies POSTECH's advanced scientific and technological expertise to the field of defense science and technology. It is designed to train specialists who can contribute to national defense through research on future combat systems and next-generation defense technologies.
Major in Management in the Steel Industry	This program offers a structured curriculum integrating core knowledge of the steel industry, foundational management principles, and key topics related to the Fourth Industrial Revolution. In collaboration with global steel companies, students participate in the capstone project that addresses real-world industry challenges and develops practical solutions. The program aims to prepare interdisciplinary professionals to lead innovation in the global steel sector.
Major in Convergence Food Technology	This program focuses on food, robotics, and information technology as its primary areas of education and research. It aims to cultivate next-generation leaders with innovative thinking and the ability to solve real-world problems through creative integration of transdisciplinary knowledge.
Major in Quantum Information Science	This program aims to train leading researchers with global competitiveness in the field of advanced quantum information technologies, including quantum computing, quantum communication, and quantum sensing. It promotes interdisciplinary research that brings together physics, engineering, and quantum information science.
Major in Industrial Data Science	This program aims to foster highly skilled professionals who can lead value creation across industries through a demand-driven data science education environment. In partnership with leading global universities, it offers a structured curriculum designed to develop creative, data-driven thinking and to prepare students to become global leaders in data-informed decision-making across diverse sectors.

Major in Social Data Science

1. Education Goals

The Social Data Science (SDS) based on the systematic curriculum aims to cultivate competent people who lead a data-driven society. The SDS is dedicated to helping students with knowledge, skills, and techniques in social sciences and data technologies make valuable contributions to the global economy, welfare, and sustainability. The SDS delivers and emphasizes a curriculum designed to develop a comprehensive understanding of complex real-world problems and creative problem-solving skills. It provides educational, learning, and research opportunities to actively respond to various social needs and to nurture students specializing both in humanities, social science, and technology.

2. Program Overview

The social data science is an interdisciplinary research-oriented graduate program. The program includes basic and advanced courses in humanities and social science and courses offered in the engineering departments to interdisciplinary education. This SDS includes specialized courses to foster social data scientists with excellence and existing courses provided by the Division of Humanities and Social Sciences, Department of Industrial Management and Management Engineering, and Department of Computer Science and Engineering, etc. Besides, through cooperation with external organizations, an education system is established that can actively respond to social and industrial demand.

The curriculum of the SDS is the harmonious composition of various courses ranging from humanities and social science to interdisciplinary education. The curriculum includes four mandatory major courses including social science and data analysis, statistical research methods, social data science seminars, and special topics on SDS. The elective courses consist of courses specialized in social data analysis and graduate courses offered by industrial & management engineering, computer science & engineering, and electrical & electronic engineering.

[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 Social Data Science has set the minimum number of credits as 28 for the Master's Program (25 course credits and 3 research credits), 60 for the MS/PhD Integrated Program (43 course credits and 17 research credits), and 32 for the Doctoral Program (19 course credits and 13 research credits), (Refer to the table for details).

[Remarks on Graduation requirements with degrees in the SDS]

A. M.S Program

- M.S Program students must take 25 course credits and 3 research credits.
- M.S Program students must take four mandatory courses including Social Science and Data Analysis (PSDS501), Statistical Research Method (PSDS502), Social Data Science Seminar (PSDS503), and Special Topics on SDS(PSDS800).

B. Ph.D Program

- Ph.D Program students must take 19 course credits and 13 research credits.
- Ph.D Program students must take at least 19 course credits regardless of mandatory and elective courses.

C. M.S/Ph.D Integrated Program

- M.S/Ph.D Program students must take 43 course credits and 17 research credits.
- M.S/Ph.D Program students must take four mandatory courses including Social Science and Data Analysis (PSDS501), Statistical Research Method (PSDS502), Social Data Science Seminar (PSDS503), and Special Topics on SDS(PSDS800).

D. Qualification Exam for Ph.D Students

- Ph.d. Students will take qualification exam based on two subjects among Social Science and Data Analysis (PSDS501), Statistical Research Method (PSDS502), and Social Issues and Trend Analysis (PSDS601).
  - The qualification exam will be exempted if students get A0 or higher in both of the above courses.
- The qualification exam must be passed within two years of admission, and a total of two opportunities are given.

[Graduation Credit Requirements]

Programs	Course Credit	Research Credit	Overall Credit
M.S	25 Credits	3 Credits	28 Credits
Ph.D	19 Credits	13 Credits	32 Credits
M.S-Ph.D Combined	43 Credits	17 Credits	60 Credits

3. Course List

Category	Course No.	Title	Lecture-Lab-Credit
Major Requirement	PSDS 501	Social Science and Data Analysis	3-0-3
	PSDS 502	Statistical Research Method	3-0-3
	PSDS 503	Social Data Science Seminar	3-0-3
	PSDS 800A-D	Special Topics on SDS	1-0-1
Major Electives	PSDS 593/EVSE593	Introduction to Big Data for Environment	3-0-3
	PSDS 601	Social Issue and Trend Analysis	3-0-3
	PSDS 602	Human Behavior, Organization, and Market Research	3-0-3
	PSDS 621/IMEN574	Programming for Data Science	3-0-3
	PSDS 641/EECE695	Special topics in Electrical and Electronics Engineering	3-0-3
	PSDS 666/IMEN666	Applied Stochastic Processes	3-0-3
	PSDS 700	Special topics in Social Data Science A/Z	1~3
	PSDS 701	Social Network Analysis	3-0-3
	PSDS 721/IMEN677	Time-Series Analysis	3-0-3
	PSDS 722/IMEN662	Discrete Optimization	3-0-3
	PSDS 723/IMEN891E	Bayesian Statistics for Data Analysis	3-0-3
	PSDS 724/IMEN881A	Business Process Management & Process Mining	3-0-3
	PSDS 725/IMEN587	Science & Technology Policy Research	3-0-3
	PSDS 726/IMEN597	Digital Management	3-0-3
	PSDS 727/IMEN572	Service Quality Engineering	3-0-3
	PSDS 731/CSED610	Information Retrieval	3-0-3
	PSDS 732/CSED518	Linguistic Basis for Natural Language Processing	3-0-3
	PSDS 763/IMEN763	Nonlinear Programming	3-0-3
	PSDS 791/IMEN891H	ST: Corp. Valuat. with case. stu.	3-0-3
	PSDS 792/IMEN891G	ST: Integrated Risk Management	3-0-3
Research Requirement	PSDS 699	Master Thesis Research	Variable Credits
	PSDS 899	Doctorial Thesis Research	Variable Credits

4. Major Field Courses Listed by Category

Classification			Category	Course Title	Remarks
Univ.	Common Subjects		Free Elective	Scientific Writing	
				Scientific Presentation	
Major	Core Requirements (or Electives)		Major Requirement	Social Science and Data Analysis	
				Statistical Research Method	
				Social Data Science Seminar	
				Special Topics on SDS A~D	
	Core Electives (Per realm)	Humanities·Society realm	Major Electives	Social Issue and Trend Analysis	
				Human Behavior, Organization, and Market Research	
				Digital Management	
				Science & Technology Policy Research	
		Data Analysis realm	Major Electives	Programming for Data Science	
				Business Process Management & Process Mining	
				Social Network Analysis	
				Service Quality Engineering	
				Information Retrieval	
				Linguistic Basis for Natural Language Processing	
				Introduction to Big Data for Environment	
				ST: Corp. Valuat. with case. stu.	
				ST: Integrated Risk Management	
		Statistical study realm	Major Electives	Time-Series Analysis	
				Discrete Optimization	
				Bayesian Statistics for Data Analysis	
				Applied Stochastic Processes	
				Nonlinear Programming	
	Interdisciplinary Electives		Major Elective	Courses offered by relevant departments (undergraduate and graduate)	Up to 6 credits of undergraduate courses are allowed

5. Departmental Curriculum Roadmap

Major	Category	Course Title
Humanities·Society realm	Major Electives per realm	Social Issue and Trend Analysis, Human Behavior, Organization, and Market Research, Digital Management, Science & Technology Policy Research
Data Analysis realm	Major Electives per realm	Programming for Data Science, Business Process Management & Process Mining, Social Network Analysis, Service Quality Engineering, Information Retrieval, Linguistic Basis for Natural Language Processing, Introduction to Big Data for Environment, ST: Corp. Valuat. with case. stu., ST: Integrated Risk Management
Statistical study realm	Major Electives per realm	Time-Series Analysis, Discrete Optimization, Bayesian Statistics for Data Analysis, Applied Stochastic Processes, Nonlinear Programming
Interdisciplinary Electives		Subjects offered by relevant departments undergraduate and graduate schools

6. Course Description

PSDS501 Social Science and Data Analysis ······ (3-0-3)

This course covers the major classical and modern theories of social science. Besides, after preparing the theoretical basis for social science, data-based analysis is conducted for major issues in each area. This provides an opportunity to discuss the validity of the theory in practice.

PSDS502 Statistical Research Method ······ (3-0-3)

The course covers the statistical methodology necessary for social science research. Specifically, it deals with multivariate normal distribution, variance analysis, repeated measurement data analysis, principal component analysis, factor analysis, regression analysis, discriminant analysis, and logistic regression.

PSDS503 Social Data Science Seminar ······ (3-0-3)

The purpose of this course is to let the students in graduate program to participate in the seminars to increase the ability to apply the theories learned to real-world problems.

PSDS593/EVSE593 Introduction to Big Data for Environment ······ (3-0-3)

The course covers introduction of big data for environment and advanced statistical techniques. The course includes a term project that design a solution to environmental issues using big data-based AI techniques.

PSDS601 Social Issue and Trend Analysis ······ (3-0-3)

This course deals with systematic analysis of social issues and their implications. For the analysis, data produced through various channels are extracted, processed, and analyzed. The course focuses on the changes in social issues and discusses the basis for those changes through data analysis.

PSDS602 Human Behavior, Organization, and Market Research ······ (3-0-3)

This course deals with psychological and social factors that are the basis of human behavior. And, it looks at the characteristics and operating principles according to the type of organization. The data analysis is also conducted on the market mechanism to investigate cooperation and competition between organizations.

PSDS621/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 wangling, visualization, supervised and unsupervised learning, professional ethics are discussed in class.

PSDS641/EECE695 Special topics in Electrical and Electronics Engineering ······ (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.

PSDS666/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.

PSDS699 Master Thesis Research ········· Variable Credits

PSDS700 Special topics in Social Data Science A/Z ········· (1-3)

This course is designed to present and discuss the current researches in the area of social data science for acquisition of new knowledge.

PSDS701 Social Network Analysis ········· (3-0-3)

This course explains theories and methodologies for social network analysis. The construction and analysis of social networks from data discuss social phenomena and individuals in society from a new perspective. It also explains various analysis methods to analyze individual relationships and discusses how the relationship between organizations, companies, and countries affects each individual's performance.

PSDS721/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.

PSDS722/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.

PSDS723/IMEN891E Bayesian Statistics for Data Analysis ········· (3-0-3)

This course introduce elementary Bayesian inference and computational methods for data analysis. Specifically, Bayesian paradigm, conjugate priors, Markov chain Monte Carlo methods, hierarchical models and variational inference are considered. Some of recent Bayesian nonparametric methods and advanced computational algorithms are also covered. Students will learn these methods with applications to real data analysis.

PSDS724/IMEN881A Business Process Management & Process Mining ········· (3-0-3)

This course covers the entire BPM life-cycle, from process identification to process monitoring, covering along the way process modelling, analysis, redesign and automation. Concepts, methods and tools from business management, computer science and industrial engineering are blended into one comprehensive and inter-disciplinary approach. Students will learn about the benefits of systematically managing business processes through BPM, how this differs from related disciplines, and the key phases of a BPM project.

PSDS725/IMEN587 Science & 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.

PSDS726/IMEN597 Digital 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.

PSDS727/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.

PSDS731/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.

PSDS732/CSED518 Linguistic 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.

PSDS763/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.

PSDS791/IMEN891H ST: Corp. Valuat. with case. stu. ··· (3-0-3)

This course provides you with the introduction to what the valuation is, valuation techniques and the applications to practical cases. Contributing and adding values to business operations by improving the business process, supply chain or any value chain is of paramount importance. On top of that,

financial valuation of investments in such operations is also critical to 1) optimize capital allocations to business units, 2) actively look for investment opportunities and thus 3) achieve the balance among growth, profitability and safety of corporations.
In this regard, the aims of this course are to help you 1) better understand how a firm can financially value its business activities and thus evaluate its own value, and 2) apply what you are supposed to learn into some cases with practical thinking. Using financial accounting information, you will be able to evaluate business projects or assets (corporations in the capital markets). This course is designed for students at the graduate level; hence the major assessment and discussions of practical cases will be at the core of their studies.

PSDS792/IMEN891G ST: Integrated Risk Management ······ (3-0-3)

This course provides you with the comprehensive discussion of risk. Risk is unrealized, but we are always facing a possibility of its realization; hence uncertainty is inherent in the concept of risk. Managing risk is at the core of the discussion on how to make a decision at every single point of time, thereby explaining the history of the human society.
Risk discussed in this course can be broadly classified into two aspects: 1) Pure risk and 2) Speculative risk. Pure risk is a risk in which its outcome is harmful in some way and can lead us only to have a chance of loss. Speculative risk is a risk in which its outcome can be beneficial in some way and may lead us to have a chance of gain. This course will guide you to explore the two aspects of risk from business, economics and engineering perspectives.

PSDS800 Special Topics on SDS ······ (1-0-1)

This course is designed to present and discuss the current researches in the area of common interest in social data science.

PSDS899 Doctorial Dissertation Research ······ Variable Credits

Major in Medical Science and Engineering

1. Education Objectives

Medical Science and Engineering aims to educate and train medical students and graduates (expected) who are aiming to obtain a medical license, as well as graduates (expected) in engineering and related fields. Through interdisciplinary research in basic science, life science, mathematics, and engineering, the program aims to foster creative and innovative MD-PhD physicians and medical scientists and engineers who can lead the fields of medical science and biomedical engineering, contributing to the promotion of human health and the development of the biotech industry.

2. Overview of Curriculum

This program operates on a new medical education system that applies the principles of science and engineering based on interdisciplinary education linked to existing departments. The education and research fields of this program are composed of Medical Science and Medical Engineering and are not separately distinguished as individual courses. Students selectively enroll in each field after consultation with their supervising professors. Along with the aforementioned major fields, the program also provides various methodologies necessary for basic, clinical, translational research, and industrialization, such as computer programming, artificial intelligence, statistics, biotech healthcare business models, medical device and new drug development and approval processes.

A. Credit Requirements

- In accordance with Article 23, Chapter 4 of the Graduate School Regulations which states, "The minimum number of credits required for completion is 28 credits for the master's program, 32 credits for the doctoral program, and 60 credits for the integrated master's and doctoral program. However, the number of credits to be completed for each course and research credit is determined by each department," this program considers the characteristics of interdisciplinary education and diversity of related academic fields. Thus, the minimum number of credits required for completion is set as follows: 28 credits for the master's program (21 credits in courses and 7 credits in research), 32 credits for the doctoral program (18 credits in courses and 14 credits in research), and 60 credits for the integrated master's and doctoral program (27 credits in courses and 33 credits in research). Specific details are as follows.

<Curriculum structure of the Medical Science and Engineering>

<table>
<tr><th colspan="2">Degree Program</th><th>Integrated Master's and Doctoral Program</th><th>Doctoral Program</th><th>Master's Program</th></tr>
<tr><td colspan="2" rowspan="2">Research Credits</td><td>33 credits</td><td>14 credits</td><td>7 credits</td></tr>
<tr><td colspan="3">※ Attendance of two university seminars is mandatory for each program</td></tr>
<tr><td rowspan="4">Course Credits</td><td>Required Courses</td><td colspan="3">(none)</td></tr>
<tr><td>Required Elective Courses</td><td colspan="3">· Choose one from: Computer Programming, Deep learning for biomedical engineering I,II, Medical device-new drug development licensing, App. of Mathematics and Big Data, Topics in Applied Mathematics, Career Design in Medical Science & Engineering, Biomedical Chemistry, Advanced, Immunology, Neurobiology, Advanced Biochemistry, Advanced Cell Biology, Clinical Anatomy and Physiology for Scientists and Engineers, Basic Clinical Pathology, Advanced Molecular Biology Ⅰ, Special Topics in Biological Physics

· Choose one from: Bioethics and Clinical Research Introduction, or Medical Scientist Career Design</td></tr>
<tr><td rowspan="2">Major Elective Courses</td><td>27 credits</td><td>18 credits</td><td>21 credits</td></tr>
<tr><td colspan="3">※ Includes required elective course credits</td></tr>
<tr><td colspan="2">Total Credits</td><td>60 credits</td><td>32 credits</td><td>28 credits</td></tr>
</table>

B. Undergraduate Course Credit Recognition Standards

- Recognition criteria: Undergraduate courses (maximum of 6 credits)
- From the 2023 academic year onwards: 300-400 level courses (G or S/U)

* Graduate School Regulations

Article 24 (Course Credits and Research Credits) Course credits refer to the credits earned through courses provided by the graduate school. However, the maximum number of credits that can be recognized as course credits from courses taken in the undergraduate program is 6 credits.

C. Recognition standards for credits from graduate courses in other departments

- Graduate students can take graduate courses (500-level to 800-level) in other departments under the guidance of their advisor, and can receive a grade of Letter Grade or S (Pass)/U (Fail).

2. Course Table

Area	Course No	Title	lec-lab.-cr.
Dept. Core Required Elective	PMSE801A	Deep learning for biomedical engineering I	3-0-3
	PMSE531/MATH532	App. of Mathematics and Big Data	3-0-3
	PMSE749/MATH749	Topics in Applied Mathematics	3-0-3
	PMSE553/CITE553	Medical Device Design Process	3-0-3
	PMSE525	Bioethics and Introduction to clinical Research	3-0-3
	PMSE526	Career Design in Medical Science & Engineering	1-0-1
	PMSE508/CHEM481B	Biomedical Chemistry	3-0-3
	PMSE513/LIFE503	Advanced Immunology	3-0-3
	PMSE515/LIFE505	Neurobiology	3-0-3
	PMSE517/LIFE502	Advanced Biochemistry	3-0-3
	PMSE519/LIFE509	Advanced Cell Biology	3-0-3
	PMSE520/CITE390B	Clinical Anatomy and Physiology for Scientists and Engineers	3-0-3
	PMSE527/MECH427	Optics and Microscopy	3-0-3
	PMSE530/CITE490J	Basic Clinical Pathology	3-0-3
	PMSE601/LIFE601	Advanced Molecular Biology I	3-0-3
	PMSE730/PHYS712	Special Topics in Biological Physics	3-0-3

Area	Course No	Title	lec-lab.-cr.
Major Elective	PMSE501/AMSE361	Introduction to Polymers	3-0-3
	PMSE502/AMSE407	Instruments for Materials Characterization	3-0-3
	PMSE503/AMSE416	Biomedical Materials	3-0-3
	PMSE504/AMSE463	Polymer Design and Laboratory	3-0-3
	PMSE505/AMSE464	Physical Properties of Polymers	3-0-3
	PMSE506/CHEM451	Macromolecular Chemistry	3-0-3
	PMSE507/CHEM461	Biochemistry	3-0-3
	PMSE509/MECH624	Biofluid Mechanics	3-0-3
	PMSE510/CITE341	Control System Theory and Experiments	3-0-3
	PMSE511/CITE452	Biomedical Device: Engineering for Diagnostics and Therapeutics	3-0-3
	PMSE512/CITE453	Biomedical Systems & Signal Processing	3-0-3
	PMSE514/CITE451	Biomaterials and Biofabrication Methods	3-0-3
	PMSE516/LIFE506	Plant Physiology	3-0-3
	PMSE518/LIFE508	Advanced Developmental Biology	3-0-3
	PMSE521/LIFE501	Virology	3-0-3
	PMSE522/LIFE622B	A.T(Trends in Cryo-em)	2-0-2
	PMSE523/CITE490C	Introduction to Medicine	3-0-3
	PMSE532/MECH532	Tissue Eng. for Mechanical Engineers	3-0-3
	PMSE551/CHEM551	Synthesis and Characterization of Macromolecules	3-0-3
	PMSE554/CITE554	Personalized Medicine for Engineers	3-0-3
	PMSE555/CITE555	Ultrasonics	3-0-3
	PMSE561/AMSE561	Nucleic Acid Biomaterials and Nanobiotechnologies	3-0-3
	PMSE562/AMSE562	Polymer Gels	3-0-3

Area	Course No	Title	lec-lab.-cr.
Major Elective	PMSE613/CHEM342	Instrumental Analysis	3-0-3
	PMSE619/CHEM619	Nanochemistry	3-0-3
	PMSE622/LIFE622C	Practical understanding of biostatistics	2-0-2
	PMSE624/CHEM624	Organic Synthesis Chemistry	3-0-3
	PMSE626/CSED526	Data Mining	3-0-3
	PMSE631/CHEB631	Advanced Biochemical Engineering	3-0-3
	PMSE641/MECH631	Scaling Laws and Biomimetics	3-0-3
	PMSE643/CHEB643	Advanced Metabolic Engineering	3-0-3
	PMSE644/CHEB644	Transciptional Regulation for Synthetic Biotechnology	3-0-3
	PMSE645/CHEB645	Protein Biosynthesis	3-0-3
	PMSE646/CHEB646	Advanced Synthetic Biology	3-0-3
	PMSE651/CITE551	Principles of Biomedical Opt. & Imaging	3-0-3
	PMSE669/AMSE669	NanoBiomaterials	3-0-3
	PMSE700/CITE700C	Special Topics in CiTE: Bioprinting & Tissue Engineering Lab	1-4-3
	PMSE701/CITE700K	Healthcare Solution Studio A	2-2-3
	PMSE702/CITE700D	Healthcare Solution Studio B	2-2-3
	PMSE703/CITE700Q	Healthcare Solution Studio C	2-2-3
	PMSE713/AMSE721K	Biomaterials and Tissue Engineering	3-0-3
	PMSE714/LIFE514	Molecular Imaging	3-0-3
	PMSE715/CSED515	Machine Learning	3-0-3
	PMSE716/LIFE516	Plant Molecular Cell Biology	3-0-3
	PMSE720/LIFE622H	A.T:Introductionto Bio-Industry	3-0-3
	PMSE721/LIFE622U	Trend in Mucosal Immunology	3-0-3
	PMSE722/LIFE622R	AT:Hypothesis-driven research	3-0-3
	PMSE723/LIFE622X	Basics & application of flow cytometry	3-0-3
	PMSE724/LIFE622X	Advanced Epigenetics & RNA Biology	3-0-3
	PMSE725/LIFE622Y	AT(Introduction to Synthetic Biology)	3-0-3
	PMSE726/PMSE726	Antibody Engineering	3-0-3
	PMSE727/LIFE622Z	Molecular Imaging	3-0-3
	PMSE728/LIFE703	Regulation of Gene Expression	3-0-3
	PMSE729/LIFE713	Advanced Plant Pathology	3-0-3
	PMSE731/IBIO711	Advanced Bio-imaging	3-0-3
	PMSE737/CHEB737	Advanced Molecular Biotechnology	3-0-3
	PMSE739/CSED539	Computer Vision	3-0-3
	PMSE801/CHEB801C	Soft Matter Interface Engineering	3-0-3
	PMSE801A-Z	Special Topics in Medical Science A-Z	credits varies
	PMSE802/CHEB801X	Crit. of Recent Research on Biotech	3-0-3
Research	PMSE699	Doctoral Dissertation Research	credits varies
	PMSE811A-Z	Graduate Seminar	1-0-1
	PMSE899	Doctoral Dissertation Research	credits varies

3. Course Description

PMSE501/AMSE361 - Introduction to Polymers ····· **(3-0-3)**

Macromolecular science has had a major impact on the way we live. It is difficult to find an aspect of our lives that is not affected by polymers. Polymers are currently used for various applications to various forms of plastics, packagings, electronics, and biology. This course presents the basic principles of polymer science with respect to the underlying physics and physical chemistry of polymers in solution and solid state. Topics include chain structures and conformation, polymerization reactions, thermodynamics of polymer solutions, characterization, polymer structure, mechanical properties.

PMSE502/AMSE407 - Instruments for Materials Characterization ····· **(3-0-3)**

This course aims to deliver underlying physical backgrounds and fundamental working principles of scientific instruments for materials characterization. Instead of merely introducing diverse instruments, the lecture mainly focuses on the basic theories of analytical instruments which are used for materials characterization at different levels (sub-atomic to macroscopic). Upon completion of this course, the students will be familiar with basic principles of sophisticated scientific instruments and the acquired knowledge can be easily extended to other instruments.

PMSE503/AMSE416 - Biomedical Materials ····· **(3-0-3)**

This course provide students with an in-depth understanding of the fundamentalconcepts (physical chemistry, chemistry, and materials science) behind the design of materials with biological functions at a molecular scale. In addition, the course includes the introduction to recent advances in drug delivery, tissue engineering, biosensors and bioimaging with nanoparticles.

PMSE504/AMSE463 - Polymer Design and Laboratory ····· **(0-6-3)**

The course helps understand the fundamental concepts of organic materials and biomaterials by measuring and analyzing components, molecular weight, and the thermal properties of polymers. It includes methods to investigate the nanostructures of crystalline organic materials and block copolymers with analytical instruments such as DSC and AFM.

PMSE505/AMSE464 - Physical Properties of Polymers ····· **(3-0-3)**

A study on the correlation between the structures and properties of polymers. This course offers the various physical properties of polymer solutions, solid phase polymers, and liquid phase polymers theoretically. Lectures and practices on computer simulations are provided to enhance an understanding of the basic concepts on polymer structures and properties in molecular domains.

PMSE506/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.

PMSE507/CHEM461 - Biochemistry ····· **(3-0-3)**

Recommended Prerequisites : General Chemistry

Introduction to basics of biochemistry and molecular biology. The course includes the structures and functions of proteins, instruments of biochemical reactions, intermediary metabolism and biomedical control mechanism.

PMSE508/CHEM481B - Biomedical Chemistry ························ (3-0-3)

1. To obtain advanced recent knowledge for drug discovery
2. To develop ability to solve scenario-based problems using the knowledge through the course
3. To present scientific proposal by the principles and information collection practice

PMSE509/MECH624 - Biofluid Mechanics ························ (3-0-3)

Biofluid flow phenomena in nature are analyzed based on fluid dynamic principles. Blood flows in cardio-vascular system and respiratory flows in human are handled. Especially, the causes and early diagnosis of circulatory vascular diseases and their diagnosis are studied. In addition, In addition, the fluid-mechanical survival strategies of living organisms including plants, insects and animals, optimized through a long history of evolution in response to environmental changes.

PMSE510/CITE341 - Control System Theory and Experiments ························ (3-3-4)

Students will study various theories related to control in general to build a broad knowledge of controls and systems at the undergraduate level. In other departments, we want to condense the subjects scattered in various subjects into one subject centered on core knowledge.

PMSE511/CITE452 - Biomedical Device: Engineering for Diagnostics and Therapeutics ························ (3-0-3)

Interest in biomedical engineering is continuously increasing due to the development of the bio-health field, and through this class, students will learn about the principles of treatment and introduction of devices for disease treatment at the physiology level such as neuroelectronics.

PMSE512/CITE453 - Biomedical Systems & Signal Processing ························ (3-0-3)

Students learn the signal processing concepts that are fundamental to signal and system analysis in linear systems in the time and frequency domains, and learn how to analyze biological systems and analyze data. The goal of this course is to understand the basics of circulatory, respiratory, and blood flow systems, and to enhance the understanding of biological systems through examples of signal processing, so that they can be used for analysis and design of biological systems.

PMSE513/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.

PMSE514/CITE451 - Biomaterials and Biofabrication Methods······························ **(3-0-3)**

Students will learn about biomaterials widely used in the field of biomedical engineering and bioprocessing technologies using them, and learn various techniques as an interdisciplinary engineer to apply them to the field of translational medicine and multi-scale human tissue simulation based on this. In particular, students will learn about the most actively applied 3D bioprinting, electrospinning method, soft lithography, and microfluidic-based processing technologies, as well as the latest trends, and learn about the physical and chemical properties of various human-compatible biomaterials (e.g., metals, polymers, ceramics, hydrogels, etc.) used in these technologies.

PMSE515/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.

PMSE516/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.

PMSE517/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 techniquesare 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.

PMSE518/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.

PMSE519/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.

PMSE520/CITE390B - Clinical Anatomy and Physiology for Scientists and Engineers······························ **(3-0-3)**

This course is an introductory course to human anatomy and physiology from a clinical perspective. Students will get a better understanding of the systems of the human body and the structure and function of the cells that comprise them. Using clinical scenarios, students will use their basic knowledge to understand pathophysiologies of diseases in the cardiovascular, respiratory, digestive, nervous, urinary, reproductive, and musculoskeletal systems. In addition, we will cover some of the major discoveries in biomedical science in the last 100 years.

PMSE521 - 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.

PMSE522/LIFE622B - A.T(Trends in Cryo-em)········· (2-0-2)

It will provide general basic knowledge about cryo-em, understand the protein structure analysis by cryo-em, and introduce the latest technologies related to cryo-em, and select papers in related fields and present related data.

PMSE523/CITE490C - 의학개론 (Introduction to Medicine)········· (3-0-3)

Introduction to Medicine introduces the basic concepts and disciplines of medicine. Medicine is a study of human health and disease, and in order to develop diagnosis and treatment for diseases, cooperation and convergence of various academic fields such as life science, chemistry, physics, and engineering as well as basic and clinical medicine are essential. This course aims to increase the understanding and accessibility of medicine for natural scientists and engineers, and to help them in biomedical and biomedical engineering research.

PMSE525 - Bioethics and Introduction to clinical Research········· (2-0-2)

1) Understand the basic concepts and methodologies of clinical medical research.
2) Interpret and evaluate the structure and methodology of clinical medical research papers applied in practice.
3) Understand bioethics related to research and remind students of the importance of complying with ethical regulations.
4) Students will be able to design their own clinical medical research.

PMSE526 - Career Design in Medical Science & Engineering········· (1-0-1)

Students will self-diagnose the prospects and environment of the future medical science field, discover their engineering imagination and capabilities, and design their careers by asking and answering questions about what kind of medical scientist they will become.

PMSE527/MECH427 - Optics and Microscopy········· (3-0-3)

In the undergraduate courses of the Department of Mechanical Engineering and the Department of Biology and Materials, students will learn the basics of optics and the principles of optical microscopy, which is a representative technology of optical imaging systems. Optics is an essential technology for precision measurement through non-contact sensing, high-resolution, high-contrast imaging, and can be used for measurement, fabrication, and image-based artificial intelligence learning. Light microscopy is a representative technology that can observe biological and material specimens in high resolution. This course focuses on the structure and utilization of optical measurement and imaging devices. Optical microscopy techniques taught include wide-field microscopy, phase microscopy, polarization microscopy, fluorescence microscopy, laser scanning microscopy, and super-resolution microscopy.

PMSE530/CITE490J - Basic Clinical Pathology ······ (3-0-3)

1) Understand basic pathologies for the conduct of medical science and medical device-related research.
2) Learn how pathology is used in research by looking at real patient cases.
3) Students will learn how to integrate multiple disease models with research so that they can be used in their own research in the future.

PMSE531/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.

PMSE532/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 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 aboratory instruction covers cell culture and scaffold fabrication.

PMSE551/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.

PMSE553/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.

PMSE554/CITE554 - Personalized Medicine for Engineers ······ (3-0-3)

Doctors have long known that people differ in susceptibility to disease and response to medicines. However, with little guidance for understanding and adjusting to individual differences, treatments developed have generally been standardized for the many, rather than the few. To overcome the current limitation, through this course, students will learn how engineering and science change medicines, what the benefits of personalized medicine are, and what the role of engineers in creating personalized medicine is.

PMSE555/CITE555 - Ultrasonics ························ (3-0-3)

Recommended Prerequisites: CITE490J/IBIO533(Biomedical Systems&Signal Processing), Engineering Mathematics (particularly Fourier Transforms), MATLAB

This course provides graduate or senior undergraduate students with fundamental physical principles and instrumentation in ultrasound imaging and therapeutics. Students learn the physics of ultrasound and core properties related to imaging and therapeutic applications, how to design, fabricate and evaluate ultrasound transducers, and how to form the images with the array-based beamforming system. They also explore advanced imaging methods and understand their advantages and limitations. Special topics including the biological effects of ultrasound and therapeutic applications, high-frequency ultrasound imaging, and cell mechanics studies are also covered.

PMSE561/AMSE561 - Nucleic Acid Biomaterials and Nanobiotechnologies ························ (3-0-3)

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

PMSE562/AMSE562 - Polymer Gels ························ (3-0-3)

This class deals with the fundamentals of the static and dynamic properties of polymer networks and gels. And it covers the synthesis and characterization of novel polymeric networks and gels such as hydrogels, ion gels, and gels of amphiphilic block copolymers. Also, the applications of gels such as the use of the gel medium for controlled drug delivery, encapsulation of proteins and enzymes, and biomimetic soft actuators will be introduced.

PMSE601/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.

PMSE613/CHEM342 - Instrumental Analysis ························ (3-0-3)

Prerequisites: Chemical Analysis

After learning the principles and structure of the modules that make up the chemical analysis instrument and the optimized coupling between the modules, the various methods of instrumental analysis are introduced. Students will learn electrical measurement methods, electrical signal processing, digitization of analog signals, signals and noise, and understand the structure and principles of the components of optical instruments. After acquiring this basic knowledge, students will study various methods of instrumental analysis, such as atomic spectroscopy, molecular spectroscopy, electrochemical analysis, and separation analysis.

PMSE619/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.

PMSE622/LIFE622C - Practical understanding of biostatistics ································ (2-0-2)

Recommended Prerequisites : Chemical Analysis

Principles of instrumental methods of analysis, and their applications to solve real-world problems

PMSE624/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.

PMSE626/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.

PMSE631/CHEB631 - Advanced Biochemical Engineering ······································ (3-0-3)

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

PMSE641/MECH631 - Scaling Laws and Biomimetics ·· (3-0-3)

The aim of this course is to provide an analytical tool for designing and characterizing micro- and macro-scale systems based on scaling laws and dimensional analysis. The application examples of scaling laws and dimensional analysis are discussed. And then, biological systems, including materials, structures, sensors, actuators and so on, are introduced. Recent progresses on biomimetic applications based on the fundamental mechanisms of biological systems and scaling laws are extensively covered. Students have a chance for reviewing recent articles and design/realize their own biomimetic systems.

PMSE643/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.

PMSE644/CHEB644 - Transciptional 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.

PMSE645/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.

PMSE646/CHEB646 - Advanced Synthetic Biology ···· (3-0-3)

This is an intensive course to study protein synthesis mechanism as well as regulation network in the biological system.

PMSE651/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.

PMSE669/AMSE669 - NanoBiomaterials ···· (3-0-3)

The convergence of recent advances in nanobiotechnology and medicine has created the new research field of nanomedicine. This course will provide students with an in-depth understanding of nanobiomaterials for nanomedicines including biosensors, medical imaging systems, drug delivery systems and regenerative medicines.

PMSE699 - Doctoral Dissertation Research ···· (credits varies)

PMSE700/CITE700C - Special Topics in CiTE: Bioprinting & Tissue Engineering Lab. ···· (1-4-3)

Theory and practice are provided on experimental methods and analysis techniques that are essential in the field of convergence tissue engineering. Through this, the lecture is structured so that it can be used immediately for the verification and implementation of individual research hypotheses and can be directly helpful in achieving research results.

PMSE701/CITE700K - Healthcare Solution Studio A ···· (2-2-3)

Overview: Students of related majors experience venture companies for social ventures and local small businesses, define tasks related to difficulties and improvements of companies in the process, and develop solutions by developing them into projects.
Goal: Proceed with the process of developing innovative solutions through environmental analysis and foundation/technology research on the problems proposed by the company.

PMSE702/CITE700D - Healthcare Solution Studio B ···· (2-2-3)

Overview: Students of related majors experience venture companies for social ventures and

local small businesses, define tasks related to difficulties and improvements of companies in the process, and develop solutions by developing them into projects.
Goal: Proceed with the process of developing innovative solutions through environmental analysis and foundation/technology research on the problems proposed by the company.

PMSE703/CITE700Q - Healthcare Solution Studio C ························ (2-2-3)

Overview: Students of related majors experience venture companies for social ventures and local small businesses, define tasks related to difficulties and improvements of companies in the process, and develop solutions by developing them into projects.
Goal: Proceed with the process of developing innovative solutions through environmental analysis and foundation/technology research on the problems proposed by the company.

PMSE713/AMSE721K - Biomaterials and Tissue Engineering ························ (3-0-3)

The class discusses on the biomaterial-based approaches for tissue engineering applications. It aims to help graduate students to get inspired for building/developing their own experimental design and future research directions.

PMSE714/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 unpresendent biological research performed with cells in living subjects and to develop new ways to diagnose diseases. Accordingly, the course is open to under and graduate students with diverse backgrounds, such as material science, and mechanical engineering and physics, as well as biological sciences, who wish to learn one of fastest-developing techniques for biological research and medical intervention.

PMSE715/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.

PMSE716/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.

PMSE720/LIFE622H - A.T:Introductionto Bio-Industry ··························· (3-0-3)
Introduce and discuss the bioindustry and immunotherapy.

PMSE721/LIFE622U - Trend in Mucosal Immunology ··························· (3-0-3)
Analyze recent research papers published in the field of mucosal immunology. In this case, after the students' presentations, there will be a Q&A session to discuss and make suggestions on critical thinking skills and improvement of presentation skills

PMSE722/LIFE622R - AT:Hypothesis-driven research ··························· (3-0-3)
This course aims to prepare junior-year graduate students and senior-year undergraduate students to learn scientific approaches driven by hypotheses that can be used to draw new conclusions from existing knowledge and/or observations, one of the most fundamental skills of a scientist.

PMSE723/LIFE622X - Basics & application of flow cytometry ··························· (3-0-3)
The goal is to understand the principles of flow cytometry/separation techniques and the research techniques using them.

PMSE724/LIFE622X - Advanced Epigenetics & RNA Biology ··························· (3-0-3)
Advanced level of epigenetics. The lecture will cover the concepts and the fundamentals of epigenetics, recent trends and clinical implications of epigenetic research, and the functional implications in various cellular and organismal contexts.

PMSE725/LIFE622Y - AT(Introduction to Synthetic Biology) ··························· (3-0-3)
This course is an introductory course in synthetic biology that aims to create and apply biological systems that do not exist in nature using various biological components.
- Understand various biocomponents and learn the composition and operation principle of biocircuits based on them.
- Understand and apply nucleic acid-based design tools and modeling/simulation tools
- Introduction to biological, medical, and industrial applications through synthetic biology

PMSE726 - Antibody Engineering ··························· (3-0-3)
Antibodies, which play an important role in the immune response, are used in various fields such as biochemical experiments, new drug development, and immunotherapy due to their high reactivity to specific antigens. Students will learn the classic methods and latest methodologies for producing antibodies with these characteristics, and understand various platform technologies based on antibodies.

PMSE727/LIFE622Z - Molecular Imaging ··························· (3-0-3)
In line with the rapidly developing trends of modern biology, lectures on the latest trends and prospects in each subfield are covered as needed.

PMSE728/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.

PMSE729/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.

PMSE730/PHYS712 - Contemporary Biophysics ···························· **(3-0-3)**

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

PMSE731/IBIO711 - Advanced Bio-imaging ···························· **(3-0-3)**

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.

PMSE737/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.

PMSE739/CSED539 - Computer Vision ···························· **(3-0-3)**

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.

PMSE801/CHEB801C - Soft Matter Interface Engineering ···························· **(3-0-3)**

Understanding the fundamentals of soft matter and interfacial phenomena are critical to the applications of all varieties of soft materials, including polymers, proteins, colloids, emulsions, and gels. This course will introduce students to the basics of polymers, interfacial phenomena, and biomaterials. Throughout the course, these concepts will be applied to a series of case studies. This course should be of interest to students studying polymer science, colloid and surface science, nanotechnology, biomaterials, and microfluidics. The emphasis of the course will be approximately 1/3 on polymers, 1/3 on interfacial phenomena, and 1/3 on biomaterials.

PMSE801A~Z - Special Topics in Medical Science A-Z ···························· **(credits varies)**

PMSE802/CHEB801X - Crit. of Recent Research on Biotech. ···························· **(3-0-3)**

This course aims to present and discuss the latest research papers and research trends in the biotechnology field

This course is expected to enhance the knowledge of the latest research trends of graduate students and young researchers, improve their presentation skills, and derive joint research

PMSE811A~Z - Graduate Seminar··· (1-0-1)

PMSE899 - Doctoral Dissertation Research·· (가변학점)

Major in Defense Science and Technology

1. The Goal of Education

The School of Defense Science and Technology aims to foster defense science and technology experts who will lead the construction of 'advanced science and technology forces' and contribute to Strengthening the military's independent R&D capabilities through interdisciplinary studies with existing departments for military consignment students, undergraduate and master's students (including expected graduates) in science and engineering.

2. Program Overview

This program operates based on interdisciplinary convergence education linked with existing departments, focusing on foundational and applied education and research in IT (AI, robotics, metaverse), mechanical and materials engineering, and industrial management engineering. While it can be broadly categorized into IT track, mechanical and materials track, and industrial management engineering track, these are not separate programs. Students, in consultation with their advisors, can selectively take courses in various fields according to their defense science and technology projects.

a. Basic Direction of the Curriculum

- Education in foundational and applied fields centered on IT (AI, robotics, metaverse), mechanical and materials engineering, and industrial management engineering.
- Completion of a thesis and feedback of research results through specialized learning and research in core areas required by the military, industry, academia, and research institutions.

b. Curriculum Structure

- Considering the characteristics of interdisciplinary convergence education and the diversity of related academic fields, the minimum credits required for completion are as follows:
- Master's program: 28 credits (19 course credits, 9 research credits)
- Doctoral program: 32 credits (18 course credits, 14 research credits)
- Integrated Master's and Doctoral program: 60 credits (27 course credits, 33 research credits).

<table>
<tr><th colspan="2">Program</th><th>Master's Program</th><th>Master's program</th><th>Integrated Master's and
Doctoral program</th></tr>
<tr><td rowspan="2">Course Credits</td><td>Major Required</td><td colspan="3">7 (Capstone Design for Defense Science and Technology A/B 4, Introduction of the Defense science and technology 3)</td></tr>
<tr><td>Major Elective Required</td><td>12</td><td>11</td><td>20</td></tr>
<tr><td colspan="2">Research Credits</td><td>9</td><td>14</td><td>33</td></tr>
<tr><td colspan="2">Total Credits</td><td>28</td><td>32</td><td>60</td></tr>
</table>

[Criteria for Taking Major Required Courses]

- Capstone Design for Defense Science and Technology: Students must take 2 credits in the 3rd semester and 2 credits in the 4th semester.
- Students must take a 3-credit course out of the 2 introductory courses (Introduction to IT, Introduction to Machinery and Materials).

[Undergraduate course credits]

- Division: Undergraduate Courses (Maximum 6 credits)
- 200 ~ 400units (G or S/U)

[Acceptance criteria for courses in other departments for graduate school]

If a graduate student takes a graduate course (500 to 800 units), he or she can take a course under the guidance of a professor, and the grade may be received as letter grade or S(pass) / U(failed).

[Advisor]

If there is a difficulty in assigning an advisor at the time of admission, a temporary advisor is designated for the first semester and a student can select an advisor for the second semester.

3. Course Table

Area	Course No	Title	lec-lab.-cr.
Major Requirement	SDST500	Capstone Design for Defense Science and Technology A	2-0-2
	SDST501	Capstone Design for Defense Science and Technology B	2-0-2
	SDST595	Introduction to IT Track of the Defense science and technology	3-0-3
	SDST596	Introduction to Mechanical engineering and Material engineering Track of the Defense science and technology	3-0-3
Major Elective	SDST502/DISU402	High-Speed Semiconductor I/O Circuit	3-1-3
	SDST503/MECH403	Introduction to Nanoscale Science and Engineering	3-0-3
	SDST513/AMSE213	Mechanical Properties of Materials	3-0-3
	SDST521/AMSE321	Introduction to Metallic Materials	3-0-3
	SDST523/EECE423	Modern Control Theory	3-0-3
	SDST531/EECE231	Basic Circuit Theory	3-0-3
	SDST534/EECE434	Introduction to VLSI Design	3-0-3
	SDST536/EECE236	Learning About Electrical Engineering Using MatLab	2-2-3
	SDST541/EECE441	Introduction to Digital Communication	3-0-3
	SDST542/NGCN301	Introduction to Communications and Network	3-0-3
	SDST550/EECE550	Advanced Computer Design	3-0-3
	SDST551/CITE551	Principles of Biomedical Opt. & Imaging	3-0-3
	SDST552/MECH451	Energy Systems	3-0-3
	SDST553/CITE453	Biomedical Systems & Signal Processing	3-0-3

Area	Course No	Title	lec-lab.-cr.
	SDST555/EECE455	Embedded System-on-Chip Design	3-0-3
	SDST561/EECE361	Electromagnetic Waves	3-0-3
	SDST575/EECE376	Electronics & Electrical Engineering Lab.3	1-5-3
	SDST576/EECE576	Statistical Communication Theory	3-0-3
	SDST584/EECE584	Advanced Electromagnetics I	3-0-3
	SDST585/EECE85	Radar System Engineering I	3-0-3
	SDST590/EECE490A	Advanced Topics in Electrical Eng A(Understanding Display Semiconductor)	3-0-3
	SDST601/MECH501	Analytical Methods in Engineering	3-0-3
	SDST651/EECE651	Computational Intelligence	3-0-3
	SDST663/EECE663	Estimation Theory	3-0-3
	SDST669/EECE669	VLSI Signal Processing	3-0-3
	SDST691A-Z	Special Topics in Defense science and technology A-Z	credits varies
	SDST695/GIFT706	Advanced Alloys and Metal Forming	3-0-3
	SDST696/EECE659U	Special Topics in Electronic and Electrical Engineering U (Understanding and Application of Mixed Reality Technology)	3-0-3
	SDST697/EECE695W	Special Topics in Electronic and Electrical Engineering W (Terahertz Imaging and Sensing)	3-0-3
	SDST706/GIFT706	Intro. to Phase-Field Model	3-3-3
	SDST713/GIFT713	Project Financing & Eng Economics	3-0-3
	SDST719/NUCE719C	Advances Nuclear Convergence for Future Social	3-0-3
	SDST750/CITE490K	Creative IT Advanced Special Lecture K: AR/VR Design & Fabrication Studio	2-2-3
	SDST751/CITE700I	Creative IT Special Topics I: Making Intro. for Graduate Research	3-0-3
	SDST752/CITE700J	High-Performance Algorithm in GPU/DSP	3-2-4
	SDST753/CITE700L	Creative IT Special Topics: Adv. Signal/Image Processing in GPU	0-2-1
	SDST754/EECE490D	Advanced Topics in Electrical Eng D (Neuromorphic Semiconductor Device)	3-0-3
	SDST755/EECE695C	Special Topics in Electronic and Electrical Engineering C (VR Technology and its applications)	3-0-3
Research	SDST699	Master's thesis research	credits varies
	SDST899	Doctoral Dissertation Research	credits varies

4. Course Description

SDST500, 501 - Capstone Design for Defense Science and Technology A, B······················(2-0-2)
Research the matters and issues needed in the military, search for solutions, find and study the issues needed in the military to which the trainee belongs, and use the results after returning to the military.

SDST502/DISU402 - High-Speed Semiconductor I/O Circuits··(3-1-3)
The High-Speed Semiconductor Input/Output Circuits course provides students with the knowledge and skills needed to understand the basic theory and operation of input/output circuits in the latest high-speed semiconductors, which can reach tens of GHz/Gbps. Through hands-on experimentation, students will learn the importance of impedance matching and gain opportunities to experiment with the operation of high-speed input/output circuits. By the end of the course, students will have gained a strong foundation in the principles of high-speed semiconductor input/output circuits and will be equipped with the practical skills needed to design, build, and test these circuits. This knowledge will be invaluable in the context of modern high-speed communication systems, where such circuits are increasingly essential.

SDST503/MECH403 - Introduction to Nanoscale Science and Engineering··························(3-0-3)
This course is an elective subject for senior students to understand the overall concepts of nanoscale science and engineering. Students can learn the fundamental concepts in the design, fabrication, manufacturing, characterization and application of various nanoscale materials and structures. The course illustrates how material properties, such as electronic, optical, magnetic, mechanical properties, can be tailored at the nanoscale. Through the course, students can develop the skill to be conversant in the multiple disciplines involved in nanoscience and nanotechnology.

SDST513/AMSE213 - Mechanical Properties of Materials···(3-0-3)
The Mechanics of Materials and Strengthening Mechanisms course introduces students to the fundamental principles of mechanics of materials, plastic deformation of single crystals, and dislocation theory. These concepts form the basis for studying the various strengthening mechanisms of materials. Students will also learn about mechanical testing and analysis, including tensile, fracture, and fatigue tests. Through a combination of fundamental theory and experimental methods, students will gain a deep understanding of the principles of mechanical testing and analysis. By the end of the course, students will be able to apply these principles to real-world problems and design materials with optimal mechanical properties.

SDST521/AMSE321 - Introduction to Metallic Materials···(3-0-3)
This class covers a basic physical metallurgy based on the structure-property relationships which are essential in the materials design of engineering alloys. The objective of this course is to provide the students with the fundamentals on the metallic materials, which includes basics of crystal structure, defects in microstructure, deformation and strengthening mechanism, phase equilibrium and phase transformation. The materials design concept of important engineering alloys will be introduced as well.

SDST523/EECE423 - Modern Control Theory··(3-0-3)

Prerequisite: Introduction to Automatic Control
The objective of this course is to obtain the fundamentals of modern control theory as follows:
- State-space representation of control systems to describe multi-input/multi-output (MIMO) systems
- Input/output relation of control systems in time-domain
- Advanced issues on stability, controllability and observability
- Stabilizability, Detectability
- Controller and Observer design

SDST531/EECE231 - Basic Circuit Theory ······ (3-0-3)
This course aims to develop the ability to analyze electric circuits. Students learn the basic concepts, current, voltage, resistance, capacitance, inductance, power and energy, impedance concept, maximum power transfer, Norton's theorem, and circuit network analysis by computer.

SDST534/EECE434 - Introduction to VLSI Design ······ (3-0-3)
Prerequisite: Digital System Design
Understanding, designing, and optimizing digital circuits with respect to different quality metrics: speed(performance), power dissipation, cost(area) and reliability.

SDST536/EECE236 - Learning About Electrical Engineering Using MatLab ······ (2-2-3)
This course will introduce Electrical Engineering to undergraduate students who have not decided on a major yet. By using an advanced and increasingly popular programming language called MatLab, students will utilize leading edge technology skills to implement practical and interesting tasks that are relevant to real life. By implementing these tasks using MatLab, students will also learn about common topics covered in Electrical Engineering.

SDST541/EECE441 - Introduction to Digital Communication ······ (3-0-3)
Prerequisite: Signals and Systems or Mathematics for Electronics and Electrical Engineers A
This course provides the basic principles of digital communication systems including digital modulation & demodulation, digital communications over frequency-flat & frequency-selective channels.

SDST542/NGCN301 - Introduction to Communications and Network ······ (3-0-3)
This course provides the foundations on the theory and practice of communications and network for undergraduate EECE/CSED/NGCN students.

SDST550/EECE550 - Advanced Computer Design ······ (3-0-3)
Prerequisites: Computer Design
Advanced computer design techniques are taught with design implementation practice using Verilog HDL and simulation. High-performances fixed and floating-point multiplier and divider(Wallace tree, Booth, etc.) design, RISC methods (register file TLB, etc), cache, pipeline, super pipeline, super scalar and other concepts are taught.

SDST551/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.

SDST552/MECH451 - Energy Systems ············ **(3-0-3)**

The Energy Systems course provides students with a comprehensive overview of various resources, power plant conversion systems, and technical issues related to energy systems. Students will learn how to use thermodynamic analysis to examine conventional and renewable energy technologies, and will assess the characteristics of current and potential future energy systems. The course will cover the design methods and improvement of capabilities of various energy systems, as well as the principles of power-generating systems. Through critical review of engineering analysis performed by others, students will develop the ability to evaluate heat and energy systems, and will gain familiarity with conventional and advanced energy systems. By the end of the course, students will have a deep understanding of the principles and practices of energy systems, and will be well-equipped to address the challenges of designing and implementing efficient and effective energy systems in the future.

SDST553/CITE453 - Biomedical Systems & Signal Processing ············ **(3-0-3)**

The Biomedical Systems and Signal Processing course offers a thorough introduction to the concepts of signals and linear systems. Students will gain a strong foundation in the fundamentals of signal classification and representation, as well as linear time-invariant (LTI) systems, time-domain analysis, and transforms including Fourier series, Fourier transforms, Laplace transforms, Z transforms, random signals, and noise. The principles will be illustrated using practical examples and analogies carefully selected to provide real-world relevance. Furthermore, the course will cover topics such as communication systems, digital filters, and medical imaging, using MATLAB codes to facilitate hands-on learning. By the end of the course, students will have a comprehensive understanding of the principles and applications of signal processing in the biomedical field.

SDST555/EECE455 - Embedded System-on-Chip Design ············ **(3-0-3)**

Prerequisites: Computer Design

Covers computer architecture, embedded programming, digital circuit and accelerator system design, laying the foundation of the academic field and teaching optimization techniques that can be applied comprehensively. Designs a system-on-chip structure integrating embedded processors and accelerators in actual Verilog language and provides a project environment that can run on commercial FPGA systems, conducting project-based learning (PBL) classes where students can optimize their own system-on-chip structures based on what they have learned.

SDST561/EECE361 - Electromagnetic Waves ············ **(3-0-3)**

Prerequisite: Electromagnetics

This course provides a taste of wide-range applications of electromagnetics

- How does a 5G smartphone works
- How to design your own microwave radar
- Why WiFi works in Space
- Deep Sea wireless communication for Nuclear submarines

SDST575/EECE376 - Electronics & Electrical Engineering Lab.3 ············ **(1-5-3)**

In order for students to be able to use the latest technology in electronic engineering to manufacture electronic devices in earnest, students will manufacture Wi-Fi wireless communication using ultrasonic waves, drone control, and machine learning devices, and students will be evaluated by them.

SDST576/EECE576 - Statistical Communication Theory······ (3-0-3)
Prerequisite: Probability and Random Process: Undergraduate level Probability theory, Signal and systems, Linear algebra
This course is designed to provide a comprehensive overview of advanced topics in signal processing and communication systems. Students will start by reviewing fundamental principles such as linear analysis, probability, statistics, and random processes. Next, they will delve into the analysis of linear and nonlinear systems with random inputs, as well as the design of systems that meet specific statistical requirements for signal detection and waveform estimation. In addition, students will learn how information theory is applied to communication systems and how to evaluate the properties of noise in such systems. By the end of the course, students will have a deep understanding of the mathematical and engineering principles that underpin signal processing and communication systems.

SDST584/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.

SDST585/EECE85 - 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.

SDST590/EECE490A - Advanced Topics in Electrical Eng A(Understanding Display Semiconductor)······ (3-0-3)
This course covers the topics that are not taught in the regular courses and/that are related to the current interests and trends. This course can be taught by visiting professors

SDST595 - Introduction to IT Track of the Defense science and technology······ (3-0-3)
Through lectures, invited lectures, presentations and discussions on various topics in the IT field, students can broaden their understanding of their major field, enhance their academic literacy, and the course provides students with the latest research topics and technology trends in the IT field.

SDST596 - Introduction to Mechanical engineering and Material engineering Track of the Defense science and technology······ (3-0-3)
Through lectures, invited lectures, presentations and discussions on various topics in the field of machinery and materials, students can broaden their understanding of their major field, enhance their academic literacy, and learn the latest research topics and technology trends in the field of machinery

and materials.

SDST601/MECH501 - Analytical Methods in Engineering ························ (3-0-3)
This course focuses on enhancing 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

SDST651/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.

SDST663/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.

SDST669/EECE669 - VLSI Signal Processing (3-0-3)
This course covers the following VLSI signal processing concepts: Iteration bound, pipelining and parallel processing, retiming and unfolding technique, folding technique, systolic array designs and fast convolution, algorithm strength reduction. Additionally, to foster a broad understanding of computer arithmetic, the following concepts are also addressed: Conventional and unconventional number systems, fast addition/subtraction, binary floating-point number system, sequential algorithms for multiplication and division, high-speed multiplication, fast division, division through multiplication. Students will engage in individual research projects focusing on signal processing algorithm optimization based on concepts learned in the course, providing hands-on design experience where theoretical principles are applied to real-world problems.

SDST691 - Special Topics in Defense science and technology A-Z ························ (credits varies)
This course is designed to help students with their research plans and post-graduation work by providing lectures on specific defense-related topics or the latest trends.

SDST695/GIFT706 - Advanced Alloys and Metal Forming ························ (3-0-3)
The object of this course is to introduce basic concepts and advanced techniques of heterostructured metallics materials, high entropy alloys, and metal additive manufacturing (3-D printing) for understanding the future and extreme material, structure, and processing. The course will cover the

topics of stress, strain, elastic constants, plasticity, dislocations, strengthening mechanisms, fracture, fatigue, high temperature deformation and hydrogen embrittlement. Selected topics including the role of various microstructural factors on the mechanical properties of steels will be discussed in the class.

SDST696/EECE659U - Special Topics in Electronic and Electrical Engineering U (Understanding and Application of Mixed Reality Technology)·· (3-0-3)

The object of this course a practice-oriented course for graduate students that utilizes mixed reality devices provided to students for learning mixed reality technology from both hardware and software perspectives. The course focuses on the understanding of mixed reality technology through theory and practical usage, acquisition of skills in developing mixed reality content through software, securing capabilities for applying mixed reality technology in other fields, and building a platform for interdisciplinary mixed reality-based courses.

SDST697/EECE695W - Special Topics in Electronic and Electrical Engineering W (Terahertz Imaging and Sensing)·· (3-0-3)

Prerequisite: Varies depending on the nature of the lecture

This course is given by a visiting professor or full-time professor who selects a title that is not specified in the existing curriculum and conducts lectures on a field of interest according to the latest trends.

SDST699 - Master's Thesis research·· (credits varies)

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

SDST706/GIFT706 - Intro. to Phase-Field Model (3-3-3)

This class covers a tour through the world of the-state-of-art phase-field modeling for describing micro-structure evolutions in materials. Main objective is to give you a feel of how phase-field modeling works. What is possible, and what are limitations? Understand how things work in phase-field modeling for microstructure predictions.

SDST713/GIFT713 - Project Financing & Eng Economics ·· (3-0-3)

This subject covers financial analysis and financing structure for successful plant projects. This subject will cover the case studies related with the actual financing models.

SDST719/NUCE719C - Advances Nuclear Convergence for Future Social···························· (3-0-3)

The course provides the introduction of 5 focused-areas ('Nuclear safety', 'Nuclear Environment', 'Plasma & Accelerator', 'Robotics & AI', 'Humanities & Social science') in the Division of Advanced Nuclear Engineering for advanced nuclear convergence for future society. Students are expected to learn actual practices based on well-defined case problems in each area.

SDST750/CITE490K - Creative IT Advanced Special Lecture K: AR/VR Design & Fabrication Studio··· (2-2-3)

This is a class to learn content production techniques using XR technology, and develop application technologies related to dance using AR, VR, XR, Computer Vision, and Stereo Camera.

SDST751/CITE700I - Creative IT Special Topics I: Making Intro. for Graduate Research·· (3-0-3)

Based on the Evidence-based MVP (Evidence-Based Minimum Viable Product), it provides opportunities for students to implement and produce their own designed projects through education on various latest Fast Prototyping technologies and equipment. Students can understand the overall maker's design process by having simple experiments every week.

SDST752/CITE700J - High-Performance Algorithm in GPU/DSP·· (3-2-4)

For higher computing performance, new processors have heterogeneous architectures where multi-core CPU and high-density GPU are integrated together, e.g., Intel's Haswell has both multi-core CPU and GPGPU. However, to achieve high performance using these processors, smart algorithms and their efficient implementations that matches to the underlying processor architecture are essential. Programming at this level is challenging. In this course, we will cover the fundamentals of high-performance programming, followed by the architecture and programming of CPU and GPGPU processors. Hands-on labs will be held for students to learn various programming techniques and experience the realization and joy of fast image/video processing algorithms on both CPU and GPGPU. The trade-offs between the ease of programming and achieved performance with these processors will be discussed.

SDST753/CITE700L - Creative IT Special Topics: Adv. Signal/Image Processing in GPU··· (0-2-1)

For higher computing performance, new processors have heterogeneous architectures where multi-core CPU and high-density GPU are integrated together, e.g., Intel's Haswell has both multi-core CPU and GPGPU. However, to achieve high performance using these processors, smart algorithms and their efficient implementations that matches to the underlying processor architecture are essential. Programming at this level is challenging. In this course, we will cover the fundamentals of high-performance programming, followed by the architecture and programming of CPU and GPGPU processors. Hands-on labs will be held for students to learn various programming techniques and experience the realization and joy of fast image/video processing algorithms on both CPU and GPGPU. The trade-offs between the ease of programming and achieved performance with these processors will be discussed.

Topics covered are

1.Introduction to high-performance programming: Instruction-level parallelism, data-level parallelism, cache architecture, data double buffering.

2.Intel's multi-core CPU architecture and programming: Architectural features of SandyBridge/IvyBridge/Haswell, streaming multimedia instruction set (SSE4/AVX/AVX2), and multi-core programming using CILK

3.Nvidia GPGPU architecture and programming: Architectural features, parallelizing an algorithm for GPGPU architecture, memory optimizations, general purpose GPGPU programming languages: CUDA and OpenCL

4.······· Image/video computing algorithms and their optimization for both CPU and GPGPU architectures

SDST754/EECE490D - Advanced Topics in Electrical Eng D (Neuromorphic Semiconductor Device)··· (3-0-3)

Prerequisite: Varies depending on the nature of the lecture

This course is given by a visiting professor or full-time professor who selects a title that is not specified in the existing curriculum and conducts lectures on a field of interest according to the latest trends.

SDST755/EECE695C - Special Topics in Electronic and Electrical Engineering C (VR Technology and its applications) ······ (3-0-3)
It aims to understand virtual/augmented/mixed reality technology, secure virtual object and virtual world design capabilities, and secure application capabilities of other fields of virtual reality technology.

SDST899 - Doctoral Dissertation Research ······ (credits varies)
In this course, students in the doctoral program will conduct research under the supervision of their respective academic advisors.

Major in Management in the Steel Industry

1. Education Aim

The master's degree program of the Management in the Steel Industry (hereafter, the MSI Program) aims to increase global competitiveness of the steel business by nurturing professionals, enabling them to adeptly navigate and make astute decisions amid the pervasive uncertainties of the corporate landscape. We eagerly welcome applications from talented individuals who have deep technical knowledge and hands-on experience in the steel industry.

2. Curriculum Overview

The MSI program offers a comprehensive array of learning opportunities. It encompasses foundational knowledge of the steel industry, steel technology, and related products.
Students also engage in a diverse selection of management courses, including financial management, marketing, human resources, economic analysis, and operations management.
The program incorporates a curriculum that facilitates systematic learning of contemporary subjects such as data analysis, artificial intelligence, and business statistics, that are vital in the era of the 4th Industrial Revolution.
Additionally, the research credit course, "Capstone Project," is conducted in collaboration with our faculty and a prominent steel company, to enable students to address practical challenges within the steel industry. This goal of this course is to foster development of students into capable individuals proficient in devising innovative solutions by engaging with real-world industries, utilizing their expertise in steel knowledge, management proficiency, and their skills in data analysis.

[Basic direction of curriculum]

- Enhancing knowledge in Steel Industry Theory and Technology
- Fostering critical thinking skills by imparting fundamentals of Business Management
- Gaining proficiency in Data Analysis and Artificial Intelligence Methods
- Cultivating a versatile business mindset by practical application of the above learning
- Providing student-centered remote education to address time and space constraints, and to encourage independent-study

[Curriculum system]

- Operated as a 1-year, 3-semester intensive course: 1st (2025-Spring semester), 2nd (2025-Summer semester), 3rd (2025-Fall semester)
- The minimum credit requirement for the completion of a Master's program: 30 credits (27 credits for coursework, 3 credits for Capstone Project)

Program	Course Credits	Research Credits	Overall Credits
M.S. (Master's degree)	27	3	30

[Notes on Completion of a Master's program]

- No other courses offered at the undergraduate level are approved for graduation
- No other courses offered by other programs are approved for graduation
- No teaching assistantship (TA) is required due to online lectures and non-resident attendance

[Thesis (Master's course)]

- The master's thesis will be replaced by the outcome of the capstone project (MSIP699). To complete the MSI program, you are required to submit a business analysis report as the outcome of the capstone project (MSIP699), the report that will be assessed at the end of the 3rd semester.

3. Course Table

Category	Course No.	Course Title	lec-lab.-cr.
MSI Core	MSIP501	Financial Management with Case Studies of the Steel Industry	3-0-3
	MSIP502	Operation Management of the Steel Industry I	3-0-3
	MSIP503	Business Statistics: Basics & Applications to the Steel Industry	3-0-3
	MSIP504	Understanding Steel Production & Products	3-0-3
	MSIP505	Introduction to Marketing	3-0-3
	MSIP506	Strategy and Innovation of the Steel Industry	3-0-3
	MSIP507	Human Resources and Organization Behavior	3-0-3
MSI Elective	MSIP601	Data Analytics & AI: Applications to the Steel Industry	3-0-3
	MSIP602	Operation Management of the Steel Industry II	3-0-3
	MSIP603	Understanding of the Steel Industry: Trends and Prospects	3-0-3
	MSIP604	Economic Analysis with Case Studies on the Steel Industry	3-0-3
	MSIP691A-Z	Special Topics in the Management of the Steel Industry A-Z	Variable Credit
Research Credit	MSIP699	Capstone Project	0-6-3

4. Course Description

MSIP501 Financial Management with Case Studies of the Steel Industry .... (3-0-3)

This course examines critical topics in corporate finance from the perspective of financial managers, who bear the responsibility of making decisions about investment and financing. It provides theory and practice of corporate financial management, such as aspects of business organizations, fundamental financial statements, present-value concepts, capital budgeting, long-term financing, cost of capital, capital structure, and dividend policy. By the end of this course, students will have acquired valuable financial knowledge and to have established a strong foundation for future advanced finance courses.

MSIP502 Operation Management of the Steel Industry I ········· (3-0-3)

This course examines various quantitative operations management problems in the steel industry, and introduces relevant fundamental optimization techniques, programming, network flow, dynamic programming, integer programming, and scheduling.

MSIP503 Business Statistics: Basics & Applications to the Steel Industry ········· (3-0-3)

This course offers an introductory overview of fundamental statistical concepts and procedures that are commonly used in the business realm. Emphasis is placed on developing familiarity with the interpretation and execution of statistical tests. Upon completion of the course, students will have acquired a solid grounding in basic statistics, encompassing topics such as distributions, correlations, t-tests, ANOVAs, and linear regression. Additionally, students will gain a foundation in programming with Jamovi/JASP statistical software, which will enable them to perform analysis, create graphical representations, and generate reproducible reports. The course will incorporate practical examples from the steel industry.

MSIP504 Understanding Steel Production & Products ········· (3-0-3)

This course commences with an overview of the process routes in integrated steelworks such as POSCO. The class will systematically delve into the fundamental principles underlying each process and product, approaching them from an academic perspective. Furthermore, the course will help students to adapt to the real-world processes and products involved in steel production. Each student is required to submit a modular report on a topic related to metallurgical processes and products, with particular emphasis on comprehending the underlying principles of steel production and products. Students in the course are also expected to gain an understanding of the practical management of each process and product treatment, a critical aspect in the field of steel production, because the efficient treatment of raw materials and control of product properties predominantly dictates the competitiveness of the entire steel production process.

MSIP505 Introduction to Marketing ········· (3-0-3)

This course will present the fundamental concepts of marketing. In addition, it will focus on the management of the marketing function within the current corporate and economic environment. The goal of marketing is to provide superior satisfaction of customer needs and wants. The marketing concepts are applicable to small, large, private, public sector, profit and non-profit organizations. The marketing of both goods and services are applicable to the concepts presented in this course.

MSIP506 Strategy and Innovation of the Steel Industry ········· (3-0-3)

This course is designed to seamlessly integrate strategy and technology/innovation, to cultivate a thorough theoretical and practical understanding of Strategic Management of Technological Innovation (SMTI). It provides students with insights into SMTI as an applied discipline they can effectively utilize. Students are also expected to develop expertise in use of analysis tools to gain a technological competitive advantage.

MSIP507 Human Resources and Organization Behavior ········· (3-0-3)

This course centers on comprehending organizations at both micro and macro levels, and to explore the fundamental processes involved in management of human resources and industrial relations in a global corporate context. The course is structured around four thematic modules that consider major topic areas: organizational behavior, organizational management, human resources management, and industrial relations. Students are expected to learn key concepts and theories in the fields of organization management and human resources management, and how to apply them in multinational manufacturing companies. Lectures, individual assignments, and group projects will help students to develop the managerial competencies in organization and human resources that are required to become future leaders in corporate settings.

MSIP601 Data Analytics & AI: Applications to the Steel Industry······································ (3-0-3)

This course delves into the principles and concepts underpinning current business analytics practices. It introduces a wide array of valuable data analytics tools, including text mining, web analytics, and network analytics. The curriculum covers the process of formulating business objectives, data selection, preparation, and partitioning, and the effective design, construction, evaluation, and implementation of predictive models for various practical business applications. These applications encompass direct marketing, cross-selling, customer retention, delinquency and collection analytics, fraud detection, machine failure detection, and insurance underwriting. The course places a strong emphasis on hands-on learning, with a focus on addressing real-world business challenges. Students will gain practical experience using Python analytics software to experiment with various analytics techniques.

MSIP602 Operation Management of the Steel Industry II·· (3-0-3)

This course represents the second part of a two-course sequence on operations management, with a specific focus on supply chain management. The significance of supply chain management has become increasingly evident during pandemic seasons. Students will acquire a foundational understanding of supply chain management and explore its potential applications in the steel covered include basic supply chain management concepts, network design, demand coordination, inventory management, transportation networks, and sustainability.

MSIP603 Understanding of the Steel Industry: Trends and Prospects································ (3-0-3)

This course provides students with a fundamental understanding of the iron and steelmaking industry, along with insights into its current trends. It also covers topics related to the historical development of the modern steel industry and its future prospects.

MSIP604 Economic Analysis with Case Studies on the Steel Industry································ (3-0-3)

This course introduces students to the fundamental principles of economics. It explores the concepts that underlie economic reasoning, and applies them to a wide range of phenomena, both within and beyond the scope of traditional economic analysis. It also addresses some of the basic tools of economic analysis. A particular focus is placed on interpreting the strategic behavior of stakeholders and their interactions within an economic system. The course content extends to applications in the steel industry.

MSIP691A-Z Special Topics in the Management of the Steel Industry A-Z··········· Variable Credit

This course introduces efforts to address management issues in the steel industry, such as securing raw materials, technology development, market development, and labor issues. Also, we hold special lectures and discussions with executives and on-site workers of steel companies. We explore theoretical solutions, including management and economic theories, to recent management issues in the steel industry.

MSIP699 Capstone Project ······ (0-6-3)

This course provides practical education, enabling students to address pending issues in the steel industry, develop solutions, and to propose innovative resolutions that apply the management knowledge and statistical methods acquired in this program.

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>
<tr><td rowspan="2">Courses</td><td colspan="2">Sports AIX Graduate Program Required Courses</td><td colspan="2">Students Main Department</td><td>Overall Credit</td></tr>
<tr><td>Course Work (SAIX 501-503)</td><td>Internship (INTN 800)</td><td>Course Credits</td><td>Research Credits</td><td rowspan="2">The rule of Main department will be applied</td></tr>
<tr><td>Credits</td><td>7 Credit Points</td><td>At least 1 credit</td><td colspan="2">The rule of Main department will be applied</td></tr>
</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

Completion	Division	Course Number	Course Title	Lecture Scoring
Core Course	Common	SAIX501	Sports ICT Convergence Research	3-0-3
		SAIX502	The Business of Sports	3-0-3
		SAIX503	Leadership: A Coach, What is a Leadership?	1-0-1
Selected Course	Track 1	CSED532/ MATH532	App. of Mathematics and Big Data	3-0-3
		EECE803	IT Research paper Presentation Skill	3-0-3
		EECE651	Computational Intelligence	3-0-3
		SAIX554	Intro. to Machine Learning System	3-0-3
		IMEN87A	Business Process Management and Process Mining	3-0-3
		CSED703B	Vison and Language	3-0-3
		IMEN473	Business Analytics	3-0-3
		EECE429	Int to Electric Power Sys Ctrl & Oper	3-0-3
	Track 2	CSED441	Introduction to computer Vision	3-0-3
		SAIX590D	ST: Deep Learning Theory	3-0-3
		CITE490K	Digital Fabrication Studio->ST: AR/VR Design & Fabrication Studio	3-0-3
		CSED442	Artificial Intelligence	3-0-3
		EECE651	Computational Intelligence	3-0-3
		CSED514	Pattern Recognition	3-0-3
		EECE695H	Deep Learning and Machine Perception	3-0-3

Completion	Division	Course Number	Course Title	Lecture Scoring
Selected Course	Track 2	SAIX695X	ST: HumanCentered Social AI syste. desi.	3-0-3
	Track 3	EECE411	Optoelectronics Display Engineering	3-0-3
		MECH439	Introduction to Robotics	3-0-3
		SAIX565	Robotics	3-0-3
		EECE490W	Flexible Electronic Materials and Applications	3-0-3
		EECE490V	Embedded SoC Design	3-0-3
		MECH527	Adv. Artificial Intelligence for M.E.	3-0-3
		SAIX490	Display Technology for Sports Goggle	3-0-3
		SAIX685	MR Technologies and Their Applications	3-0-3
		EECE429	Int to Electric Power Sys Ctrl & Oper	3-0-3
		SAIX555	Embedded System-on-Chip Design	3-0-3
Research Course	Common	INTN800	Internship Program	Variable Credit
		EECE699(1-9)	Master Thesis Research	Variable Credit

4. Course Description

SAIX501 Sports & ICT Convergence Technology······························(3-0-3)

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······························(3-0-3)

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·· (1-0-1)

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]

Programs	Course Credit		Research Credit	Overall Credit
	Common Subjects	Major Elective		
Master's Program	3	3	*	*
Doctoral·MS/PhD Integrated Program	5	6	*	*

(* : 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

Category	Area	Course No	Title	lec-lab.-cr.	etc
major subjects	Semiconductor	PSEP501	Introductory Semiconductor Engineering	3-0-3	Applied according to departmental regulations.
		PSEP502	CMOS Fabrication Laboratory	2-2-3	
		PSEP601 (EECE695K)	Samsung Semiconductor Device	3-0-3	
Major Elective	liberal culture	PSEP503	Design Thinking Studio on Intelligence Weaved	1-0-1	Exclusion from graduation credits. (Applicable to all departments)
		PSEP504	Design Thinking Studio on Intelligence Weaved	2-0-2	
		GEDU501	Scientific Writing	3-0-2	Applied according to departmental regulations.
		GEDU502	Research Paper Presentation Skill	3-0-2	

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.

GEDU501 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 hilp in this process. There will be no formal examinations; all marks will be based on exercises, assignments, and the final manuscript.

GEDU502 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.

POSTECH AI-ENVIRONMENT Program

1. Program Goals

The goals of the POSTECH AI-ENVIRONMENT program are 1) to provide graduate students with a new curriculum that applies AI technology to diverse environmental problems and solutions, 2) to create opportunities to develop interests in sustainable development and environmental issues, and 3) to meet the emerging demands of new value creation and convergence research in the field of environmental science and engineering.

2. Program Overview

The POSTECH AI-ENVIRONMENT program consists of the courses offered by the Division of Environmental Science and Engineering and the AI Graduate School. Through the courses, graduate students will advance the fundamental understanding of environmental issues, develop the cutting edge AI techniques, and explore ICT-based environmental solutions and new value creation opportunities.

3. Required Coursework Program Overview

● **Required credits: 13 credit hours (B+ or higher grade required for each course)**

● **Division of Environmental Science and Engineering: Seven credit hours**
- Two required courses + one elective course

● **Graduate School of Artificial Intelligence: Six credit hours**
- Two three credit-hour courses are required.
- Each course should be in a different topic among the following three topics (Topic A, B, and C).

Type	Course code	Course title	Credit
Required	EVSE593	Introduction to Big Data for Environment	3-0-3
	EVSE599	Research Seminar	1-0-1
Elective	EVSE510	Introduction to Environmental Engineering	3-0-3
	EVSE575	Global Environment	3-0-3
	EVSE579	Environmental Statistics	3-0-3
	EVSE582	Introduction to Climate Change	3-0-3
	EVSE680 A~Z	Special Topics in Environmental Engineering A-Z	credits varies

Topic	Course Code	Course title	Credit
A Machine learning/ Deep learning	AIGS515	Machine Learning	3-0-3
	AIGS538	Deep Learning	3-0-3
B Big Data/ Data mining	AIGS526	Data Mining	3-0-3
	AIGS532	Applications of Mathematics and Big Dats	3-0-3
	AIGS540	Big Data processing	3-0-3
C AI application and special topic	AIGS511	Introduction to Virtual Reality	3-0-3
	AIGS523	Statistical Natural Language Processing	3-0-3
	AIGS539	Computer Vision	3-0-3
	AIGS571	Business AI	3-0-3
	AIGS703 A~Z	Topics in Artificial Intelligence A-Z	3-0-3

4. Course Description

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.

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.

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.

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.

EVSE593 Introduction to Big Data for Environment ···· (3-0-3)

This course covers introduction of big data for environment and advanced statistical techniques and the development of the intermediate-level programing skill for Python. This course includes an independent term project that aims to design a solution to environmental issues using big data-based AI techniques.

EVSE680 Special Topics in Environmental Engineering A-Z ···· (credits varies)

Special topics in environment-related issues that are not covered by regular courses can be offered through this course when needed.

AIGS511 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.

AIGS515 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.

AIGS523 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.

AIGS526 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.

AIGS532 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.

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 ························ (3-0-3)

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.

AIGS571 Business AI ························ (3-0-3)

This course introduces the trend of technology based startups (especially digital transformation) and analyzes the frameworks and cases of AI technology commercialization and application. By studying the application of various AI technologies in real industrial sites and applying the datas and algorithms, students will get a chance to find appropriate technology

AIGS540 Big Data processing ························ (3-0-3)

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.

AIGS703A-Z Topics in Artificial Intelligence A-Z ························ (3-0-3)

This course covers advanced topics in artificial intelligence research.

POSTECH AI for ChE Program

1. Program Goals

The goals of the POSTECH AI-Chemical Engineering program are 1) to provide graduate students with a new curriculum that applies AI technology to diverse chemical engineering problems such as energy/environment, bio, materials, and the solutions, 2) to create opportunities to develop interests in sustainable development and chemical engineering issues, and 3) to meet the emerging demands of new value creation and convergence research in the field of chemical engineering.

2. Program Overview

The POSTECH AI-Chemical Engineering program consists of the courses offered by the Department of Chemical Engineering and the AI Graduate School. Through the courses, graduate students will advance the fundamental understanding of chemical engineering issues, develop the cutting edge AI techniques, and explore ICT-based chemical engineering solutions and new value creation opportunities.

3. Required Coursework Program Overview

● POSTECH graduate students from all majors (MS, PhD, and Integrated MS-PhD)

● Required credits: 13 credit hours / B+ or higher grade required for the subjects from the applicant's own department and S required for the subjects from other departments (6 credits from the AI graduate school, 7 credits from the department of chemical engineering)

● The completion of the Program will be officially acknowledged in the Diploma and Transcript.

● Department of Chemical Engineering: Seven credit hours

- One required course + one elective course(ChE AI Basic) + one elective course(ChE Domain)

Type	Course code	Course title	Credit
Required	CHEB811A~Z	Graduate Seminar A~Z	1-0-1
Elective (ChE AI Basic)	CHEB551	Engineering Optimization	3-0-3
	CHEB745	Numerical Analysis in Chemical Engineering	3-0-3
	CHEB746	Molecular Simulation for Chemical Engineers	3-0-3
	CHEB751	Advanced Process Design	3-0-3
	CHEB801R	AI Application to Chemical Engineering	3-0-3
Elective (ChE Domain)	CHEB611	Advanced Reaction Engineering	3-0-3
	CHEB643	Advanced Metabolic Engineering	3-0-3
	CHEB646	Advanced Synthetic Biology	3-0-3
	CHEB737	Advanced Molecular Biotechnology	3-0-3
	CHEB760	Polymers Blends	3-0-3
	CHEB763	Conducting Polymers and Characterization	3-0-3
	CHEB770	Semiconductor Materials and Devices	3-0-3
	CHEB776	Interface and Adhesion for Electronic & Infromation Materials	3-0-3

● Graduate School of Artificial Intelligence: Six credit hours

- Two of three credit-hour courses are required.

Course Code	Course title	Credit
AIG515/CSED515	Machine Learning	3-0-3
AIGS526/CSED526	Data Mining	3-0-3
AIGS531/MATH530	Mathematical Statistics	3-0-3
AIGS532/MATH532	Applications of Mathematics and Big Data	3-0-3
AIG537	Artificial Intelligence & Data Science	3-0-3
AIG538	Deep Learning	3-0-3
AIGS540	Big Data processing	3-0-3
AIGS610/CSED610	Information Retrieval	3-0-3

4. Course Description

CHEB551 Engineering Optimization ························ **(3-0-3)**

Mathematical formulation and its solution methods of optimization problems in chemical process are treated. Linear Programming, Nonlinear Programming, Mixed Integer Programming, multi variable optimization and constraints are dealt with practical examples.

CHEB611 Advanced Reaction Engineering ························ **(3-0-3)**

Instruction on chemical kinetics and reactor design. Course covers derivation of rate law, application of reaction kinetics for reactor design, analysis and design of reactors in homogeneous and heterogeneous phase. Application examples cover catalytic reactors, biochemical reactors, CVD reactors and polymerization reactors.

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.

CHEB646 Advanced Synthetic Biology ························ **(3-0-3)**

This is an intensive course to study protein synthesis mechanism as well as regulation network in the biological system.

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.

CHEB745 Numerical Analysis in Chemical Engineering ························ **(3-0-3)**

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.

CHEB746 Molecular Simulation For Chemical Engineers ························ **(3-0-3)**

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 ························ **(3-0-3)**

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.

CHEB760 Polymers Blends ··· (3-0-3)

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 ··· (3-0-3)

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

CHEB770 Semiconductor Materials and Devices ··· (3-0-3)

This course will provide a fundamental understanding of emerging semiconductors (metal oxide, perovskite, organic) and related device physics based on a solid understanding of silicon semiconductors and device physics.

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

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

CHEB801R Artificial intelligence for chemical engineering ··· (3-0-3)

CHEB811A-Z Graduate Seminar A-Z ··· (1-0-1)

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

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.

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.

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.

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.

AIGS540 Big Data processing ························ **(3-0-3)**

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.

AIGS610/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.