Description of Courses

❒ Undergraduate Program

BiS200 Introduction to Bioinformation and Bioelectronics
This course discusses basic knowledges for interdisciplinary research area among biology, medical, information, electronic and mechanical engineering. This course, also, provides common tool for scientific understanding of biological operation mechanism, analysis of organism structure, and principle of life. Basic theory and tool for recognition and detection, analysis and treatment, control and handling, storage and usage of biomaterials and bioinformation are discussed.

BiS221 General Biochemistry
This course covers basics of biochemistry for describing biological phenomena and its application to biological research.

BiS222 General Cell Biology
This course covers fundamental topics in DNA chemistry, including: the structure and function of DNA, the biosynthesis of DNA, the regulation of gene expression, and the mutation and DNA repair.

BiS223 Biological Physics
This course covers physical principles including thermodynamics, mechanics, energetics, kinetics, transport phenomena, and molecular forces that are needed to study and model the structure and function of biological structures.

BiS232 Bio-Data Structures
This lecture introduces data structures and algorithms for computer programming. It covers design of data structures and algorithms for bio-data analysis.

BiS252 Fundamentals of BioElectronics
As the basic course of the BioElectronics, the system analysis and modeling methods will be studied. Especially the probabilistic models in both static and dynamic forms, the convolutive model for the linear time-invariant dynamic systems, and the differential equation model for more general nonlinear time-variant biosystems will be introduced.

BiS271 BioNanoEngineering
This course offers science and technology fundamentals involved in BioNanoEngineering. Topics include the principles, materials and applications of electromechanical, thermofluidic, biochemical and optoradiative functions in bio-oriented and bio-inspired nanoengineering systems.

BiS272 Biomechanics
This course offers fundamentals of the statics and mechanics involved in deformable biological and engineering structures. Focus has been placed on the understanding of the internal status and behavior of deformable bodies subject to external forces and moments at static equilibrium. Topics include static equilibrium, force and deformation, stress and strain, yield and failure, design and analysis of the biological and engineering structures.

BiS321 Systems Bioengineering
This course discusses the basic concepts of systems biology and practical applications of bioengineering to biomedical, food, environmental, energy and electronics industry. This course also covers the following topics

in the field of new biotechnology: the nature of living things and the principles of manipulating them; enabling technologies; different approaches of biotechnology; specific applications such as medical, industrial, and environmental; and social issues such as intellectual property, regulations, biotech business, and biowarfare.

BiS324 Biochemistry and Biotechnology Laboratory
The objective of this experimental course is to provide students with the basic skills and knowledge for biochemistry and molecular biology.

BiS331 Bio Computer Engineering
This course introduces essential concepts and techniques in computer software and hardware for developing biosystems. Core software techniques including operating systems, database systems, and artificial intelligence are explained.

BiS332 Bio-Database System
Fundamental structures, and operation principles of database systems are introduced in the viewpoint of handling bio-data such as nucleotide / protein sequences, bio-molecule structures, and high dimensional numeric data. It covers the entity-relationship model, relational model, SQL, XML, and database design methodologies.

BiS333 Bioinformatics Engineering
Algorithms and application programs in bioinformatics for studying BioSystems are discussed. Topics include bio-database search, sequence alignment, gene prediction, protein structure prediction, microarray data analysis, and biological network.

BiS350 Biological Instrumentation Laboratory
Instrumentation and computer interfaces are studied for bioinformatics and bioelectronics researches. We will first study data acquisition and output as well as Analogue-to-Digital and Digital-to-Analogue data conversion. Then, term projects will be conducted for measurements of biological signals such as EEG.

BiS351 Biological Signal Processing
Signal processing algorithms for biological signals and their applications are studied. We first study linear system theory for the input-output relationship in time and frequency domains with Fourier transform. Then, z-transform of digital signal is studied, and DFT and FFT algorithms are introduced for frequency analysis. Frequency filtering with FIR / IIR filters and data analysis with PCA and k-means clustering are also studied.

BiS353 Neural Information Processing Algorithm
Information coding and unsupervised learning in biological neural systems are studied. We will first study simple neuron models for neural pulse generation and information representation. Then, self-organizing learning algorithms of massive neural systems will be introduced, and their clustering and Classification performance will be studied.

BiS354 Analog Microelectronic Circuits
Basic operational principle and equivalent circuit models are introduced. Then, several circuits are studied for rectifiers, amplifiers, and differential amplifiers are investigated. Also, wide-band amplifiers, feedback, output stage, and OP amplifiers will be studied. Finally, several circuits are introduced for data conversion, frequency filtering, and oscillators.

BiS355 Digital System Laboratory and Bio-Application

Digital logic is studied for understanding operation of computing systems. Also, digital system design and computer interface are studied. Especially, binary system, Boolian logic, combinatorial and sequential logic, and multiplier unit are investigated. Also, basic operation of microprocessors are studied, and several experiments will be conducted with microprocessors.

BiS355 Digital System Laboratory and Bio-Application

Digital logic is studied for understanding operation of computing systems. Also, digital system design and computer interface are studied. Especially, binary system, Boolian logic, combinatorial and sequential logic, and multiplier unit are investigated. Also, basic operation of microprocessors are studied, and several experiments will be conducted with microprocessors.

BiS371 Biofluidics

This course introduces basic concepts of biological transport phenomena and helps the design of micro/nanofluidic devices for medical and biotechnological applications. This course also covers topics in biofluid mechanics, mass transport, and biochemical interactions, with engineering concepts motivated by specific biological problems.

BiS372 Dynamic Motion and Response

This course offers fundamentals of the kinematics and dynamics involved in the motion of biological and engineering systems. Focus has been placed on the understanding of the motion and dynamic behavior of the systems subject to external dynamic forces and moments. Topics include kinematics, particle and rigid body dynamics, motion and dynamic response, design and analysis of the biological and engineering systems.

BiS400 Special Topics on BioSystems

Recent research trends and new research topics are investigated in the field of BioSystems. Special emphasis is given to technologies related to fusion of bioinformatics, bioelectronics, and technology. The topic may be different for each course offering, and the topic may be used as the co-title.

BiS410 Bio-Fusion Project

Students learn how to integrate the bio-information, bio-electronics and bio-nano technologies while designing and implementing bio-fusion systems. All research teams are required to present the results, and write a paper.

BiS421 Human Physiology

This course introduces the physiological principles in the human body. Students learn how major physiological systems function and interact.

BiS422 Science Communication & Leadership

'Science Communication and Leadership' provide students with scientific (or technical) writing for the public and presentation to the scientists and the public. It also provide them with an opportunity to improve their own leadership.

BiS423 Molecular Biology

This course covers fundamental topics and experimental techniques of cellular and molecular biology. Special topics include transcription, translation, and DNA replication, etc.

BiS424 Instrumental Analysis for Biomaterials

Basic principles and applications of analytical chemistry and instruments in biological sciences will be covered and discussed in this course.

BiS431 System Modeling
Formal mathematical models such as Petri-nets, automata and hidden-Markov models are explained along with their properties and analysis methods, respectively. Bio-sequences, protein motifs, protein structures, metabolic pathways, signal pathways, and regulatory networks are represented and analyzed with such mathematical models.

BiS432 Bioinformatics and Biostatistics
Basic methods of bioinformatics are introduced, which includes bio-database search techniques, bioinformatics software applications, sequence alignment, mRNA expression analysis, and protein expression analysis. In addition, basic statistical techniques for bioinformatics are introduced.

BiS451 Cognitive Neuroscience
Human cognitive functions are understood and their mathematical models are developed. We first study measurement techniques for brain signals such as EEG and fMRI. Then, cognitive models are developed for learning, memory, language, emotion, and behavior.

BiS471 Bio-Inspired Systems
This course provides scientific foundation and engineering platform for the bio-inspired systems, where bio-inspired sensors, actuators and controllers are linked together to achieve new or advanced functions. Topics include the physical and functional analogy of biological and engineering systems; the principles and methods of sensory, locomotive and neural functions; the quantitative analysis and engineering design of bio-inspired systems. Required are the technical reporting and the oral presentation of term projects on bio-inspired systems for applications to the areas of information and communication, electronics and appliance, automotive and aerospace, biomedical diagnosis, environmental monitoring and/or industrial instrumentation.

BiS472 Micro Heat & Mass Transport
This course discusses analysis tool and phenomenon of heat and mass transfer in microregion, and provides micro heat transfer through conduction, convection and radiation. Also, basic principles and applications of material diffusion and reaction are discussed.

BiS473 Bio-MEMS Laboratory
This course provides hand-on experiences on the microfabrication and characterization of bio-oriented and bio-inspired microelectromechanical systems (bio-MEMS). Lecture and laboratory topics include the basic fabrication technologies and process monitoring methods for bio-MEMS devices for BINT (Bio-Information-Nano Technology) applications. Required are the experimental work and laboratory reports on the fabrication process and characterization results. Submission and oral presentation of final term papers are also required.

BiS490 Graduation Research
BiS495 Individual Study

BiS496 Seminar

❒ Graduate Program

BiS500 Bioinformation and Bioelectronics

This course discusses recent research trend of interdisciplinary research area among biology, medical, information, electronic and mechanical engineering. By providing the newest research method and application of bioelectroinformatic systems, this course serves design, analysis and development ability for bioelectroinformatic systems.

BiS510 Technology Commercialization and Venture Business

Technology Commercialization and Venture Business provide students with theoretical and practical basis for commercialization of cutting edge technologies and establishment of venture business.

BiS521 Biology for Engineers

This course deals with biology fundamentals and associated subjects required for engineers to understand and acquire multidisciplinary technology in the fused areas of biological sciences and engineering. To accommodate those who do not have the biological background, the course covers the biological principles and engineering applications of general biology including: biochemistry, genetics, and physiology. Subsequently, special emphasis is placed on applying engineering concepts to biological problems.

BiS522 Genomics and Proteomics

This course describes the determination of the nucleotide sequence as well as many further analyses used to discover functional and structural gene information on all the genes of an organism. This course deals with the basic genetic analysis on a genome-wide scale.

BiS523 Information and Electronics for Scientists

This course is designed to provide basic knowledge on the information and electronics for the biosystems education and researches. The first half will be devoted to C language, while selected topics from undergraduate Electrical Engineering courses will be taught at the second half.

BiS525 Brain Dynamics

This course describes various brain functions with a dynamical point of view and briefly reviews the theoretical aspects of brain functions using nonlinear dynamics and information theory.

BiS531 Bioinformatics

Fundamental bioinformatics techniques including sequence analysis, genomic sequencing, protein motif analysis, cDNA chip data analysis, SNP analysis, 2D PAGE and MALDI analysis, and pathway analysis, are explained for bioinformatics software developers and practitioners.

BiS532 Bioinformatics Laboratory

The operation principles and application methods of essential bioinformatics software are exercised, which include sequence search, multiple sequence alignment, motif search, mRNA expression analysis, protein expression analysis, metabolic pathway analysis, signal transduction analysis, regulatory network, and so on. In addition, search methods for various bio-databases are exercised.

BiS533 Computing Technology

Strength and limitation of modern computing technology is discussed fundamentally in depth. It manifests the inherent characteristics of bio-information and electronics systems based on modern computing technology. This insight leads to creative discussion about novel computing paradigms based on biological principles.

BiS551 Medical Image Processing

Processing and visualization of biomedical images are studied for medical diagnosis. Basic theories for biomedical image acquisition, processing, visualization, image fusion and registration, 3-D visualization, and

virtual reality for medical operations are discussed.

BiS552 Digital Biomedical Signal Processing
Advanced digital signal processing techniques are discussed for biological signals. Especially, digital signal processing methods are studied for detection, wavelet, time-frequency joint representation, and FIR/IIR filters. Also, Wiener, Kalman, eigen, and LMS adaptive filters are studied with their applications to biological signals.

BiS554 Neural Networks
Theory, applications, and implementations are studied. We first introduce two basic learning rules, i.e., Hebbian learning rule and error back-propagation rule, and discuss network architectures and learning algorithms for several neural network models. Major applications and neuromorphic hardware implementations are also studied.

BiS571 BioElectroMechanics
This course provides electromechanics for understanding and analysis of biomechatronic systems. An analogy between mechanical systems and electrical systems, modeling of electromechanical systems, and working principles of biomedical, diagnostic, surgery and therapeutic equipments are discussed.

BiS572 Microtransducers and Laboratory
This course discusses working principles, materials, configurations and performance specifications of microtransducers based on MEMS technology. On these basis, experiments using mechanical, electrical, optical, thermofluidic and biochemical microtransducers, are provided.

BiS573 Biophotonics
This course teaches fundamental principles and contemporary applications of biophotonics. It will cover ray and wave optics, fiber optics, photonics semiconductors and biophotonic materials for understanding modern biophotonic sensing and imaging techniques.

BiS622 Metabolic Engineering
This course introduces the basic theory and practical applications of metabolic engineering offering systematic analysis of complex metabolic pathways and ways of employing recombinant DNA techniques to alter cell behavior, metabolic patterns, and product formation.

BiS623 Bioelectronic Devices
This course covers advanced topics in the design and industrial application of bioelectronic devices such as biosensor and biochip. The fundamental principles in these areas have emphasized to understand the biological recognition mechanism of enzyme, antibody, microorganism, animal cell, and DNA.

BiS631 Data Mining
Data mining techniques to discover useful patterns and regularities from the vast amount of bio-data are explained. After understanding the principles of representative data mining tasks such as classification, clustering, and association discovery, actual experiments using existing data mining software systems are performed.

BiS632 Bio-Statistics
Statistical principles and techniques such as probability distribution, hypothesis testing, regression, principal component analysis, which can be applied to various bioinformatics tasks, are introduced. Such statistical techniques are explained along with their applications to bio-sequence homology search, structure homology

search, mRNA expression analysis, protein expression analysis, and so on.

BiS634 Database Construction
System architectures and database design methodologies for constructing bio-databases are discussed. Client-server and web-based architectures are introduced, and the three-step database design procedure consisting of conceptual, logical, and physical design are explained. In addition, integration techniques of multiple heterogeneous bio-databases are examined.

BiS651 Hearing and Auditory Model
We study basic concepts of acoustic wave propagation and scattering, and human auditory systems based on cognitive, acoustic, and signal processing perspectives. By analysing huge amounts of cognitive science experimental data, we propose mathematical models for non-linearity, time-adaptation, masking, etc. Also, the connection of this data to information theory is investigated, and finally, applications to speech recognition are studied.

BiS652 Human Visual Model
Human visual system is studied with cognitive scientific and signal processing perspectives. By analysing huge cognitive science experimental data, we will come up to mathematical models. Also, its connection to information theory is investigated, and finally applications to real-world image recognition and target tracking are studied.

BiS653 Biomedical Imaging System
Theory and applications of several biomedical imaging systems are studied. Especially, X-ray imaging, ultra-acoustic imaging, X-ray CT, MRI, PET, and PACS are discussed.

BiS671 Nanomaterial Process and Behavior
This course treats the topics of properties, behaviors and controls of nanoparticles, and introduces machining processes of nanomaterials. Stability, reproducibility and reliability of nanoparticles and nanomaterials are discussed.

BiS672 Nano Electro Mechanical Systems
This course discusses physical phenomena and engineering problems arising from nanometric area. Topics included are analysis of the nano physical principles and design of the working principles, nano materials and its fabrication processes, and nano testing and chacracterization techniques. This course also provides basic knowledge of the Nano Electro Mechanical Systems (NEMS). Term projects and presentation are required.

BiS721 Computational Cell Biology
‘Computational Cell Biology’ provide students with dynamical modeling in cell biology. It also provide them with new paradigm for understanding biological systems as complex systems.

BiS722 Cell Signaling Network
‘Cell Signaling Network’provide students with fundamental understanding of intracellular signaling and intercellular communication. It also provide them with new concept of drug development targeting cell signaling.

BiS731 Bio-Pattern Recognition
Pattern recognition techniques for bio-images such as DNA chip images and electrophoresis images are discussed. After explaining deterministic, statistical, and syntactic pattern recognition principles, the feature

extraction / selection and noise handling problems for bio-images are discussed.

BiS732 Bio-Network

Formal representation and analysis of bio-processes including metabolic pathways, signal transduction pathways, and regulation networks are examined. After broadening the understanding of formal representation tools such as graphs, Boolean networks, and Bayesian networks, individual research projects for bio-network modeling are carried out.

BiS733 Bio-Intelligence

The principles and applications of intelligent systems, simulating and representing bio-mechanism, are discussed. After introducing genetic algorithms, evolutionary computing, fuzzy computing, and artificial neural networks, creative ideas for novel computing paradigms are discussed.

BiS734 Information Processing for Genomics and Proteomics

Information processing techniques for genomics and proteomics are discussed. After introducing the principles of various genomics experiments, informatics techniques for gene discovery, comparative genomics and gene expression analysis are discussed. In addition, proteome informatics for protein expression analysis, protein-protein interaction analysis and virtual cell simulation is discussed.

BiS735 Computer Graphics and Bio-Application

After basic concepts and techniques of computer graphics are discussed, essential techniques to model and represent bio-molecules such as mRNA and proteins, and various organs are discussed in two and three dimensional space. In addition, representative bio-information graphics systems are introduced.

BiS752 Neural Engineering

This course covers basic principles, theories, and methods in several important areas in the field of neural engineering including neural prostheses, brain-computer interface, and neuro-microsystems.

BiS771 Nanobiotechnology

This course discusses microenergy conversion and transfer as well as the property and behavior of micromaterials based on mechanical, material, physical, chemical and biological analysis of biomedia and their reactions. Topic included are nanoscale phenomena in cellular physiology / metabolism, micro / Nano fabrication processes with unusual materials, microfabricated tools for neuroscience, biological motors and nanobiochips.

BiS772 Nano/Micro-Machining Process Laboratory

This course discusses equipments and processes of nano / micro fabrication. Also, practices of nano / micro fabrication are provided. Term projects and presentation based on design, fabrication and test of nano / micro devices are required.

BiS800 Special Lecture on Bioinformatics & Bioelectronics

Recent research trends and new research topics are investigated in the field of bioinformatics and bioelectronics. Special emphasize is given to technologies related to fusion of bioinformatics, bioelectronics, and technology. The topic may be different for each course offering, and the topic may be used as the course co-title.

BiS810 Leadership & Communication

Leadership & Communication provides students with scientific (or technical) writing skill for the public and presentation skill to the scientists and the public. It also provides them with an opportunity to improve their

own leadership to be creative leaders for future.

BiS960 Thesis/Dissertation Research (Master)

BiS965 Individual Study (Master)

BiS966 Seminar (Master)

BiS980 Thesis/Dissertation Research (Doctoral)

BiS986 Seminar (Doctoral)

BiS987 Advanced BioSeminar
In this course, graduate students provide an oral presentation on their recent ongoing work in order to have comments from students and professors in other research fields within bioengineering.