Dept. of Intelligent Semiconductor and Display Engineering

The Department of Intelligent Semiconductor and Display Engineering was established in 2023 to foster global creative talent specialized in the field of intelligent semiconductor and display engineering, to carry out technology-leading creative innovative research and efficient industry-university cooperation research. Through interdisciplinary convergence in various fields such as physics, chemistry, and materials science for intelligent semiconductors and display technology, the curriculum for next-generation intelligent semiconductor devices and sensors for artificial intelligence and next-generation displays is systematically established with the top-tier research infrastructure.

❑ Intelligent Semiconductor and Display Engineering Major

This major aims to nurture creative talent and conduct high-level leading research for the realization of intelligent semiconductors and display devices/circuits/systems, which are one of the cores of the 4th industrial revolution.

☐ Major Courses

· Fundamentals of Artificial Intelligence for Semiconductor Engineers

Fundamentals of Artificial Intelligence for Semiconductor Engineers is set to provide graduate students working in the intelligent semiconductor&display field with basics of artificial intelligent and its application.

· Fundamentals of Semiconductor for Artificial Intelligence

This course aims to provide basic knowledge of semiconductor technology related to artificial intelligence implementation. Artificial intelligence implementation requires knowledge of high-performance semiconductor technologies such as semiconductor devices, memory arrays, analog and digital circuits.

· Nanostructure Semiconductor Device Technology

The principle and applications of nano-structure, nano-scaled semiconductor devices, including electrical and optical devices, will be discussed in this lecture, based on the advanced quantum mechanics.

· Modeling of Nanostructure Semiconductor Devices

Modeling of Nanostructure Semiconductor Devices class covers characterization, modeling, and extraction of model parameters in scaled nano-structure semiconductor devices. This is intended to integrated design and implementation of high performance of nano-structure semiconductor devices fully considering material-device-circuit perspectives.

· High-Speed and High-Frequency Semiconductor Devices)

In this lecture, high-speed and high frequency characteristics of microwave- and millimeterwave devices, such as the compound semiconductor devices, i.e., HEMTs (high-electron mobility transistor) and HBTs (heterojunction bipolar transistors), will be discussed in detail. Moreover, design guideline and implementation method, characterization techniques will also discussed.

· Advanced Topics on Semiconductor Device Physics & Char- acteristics

Electrical characteristics of unipolar-type IC devices (JFET, MOSFET, and MESFET), as analog or digital IC components, will be discussed in detail.

· Characterization of Semiconductor Materials and Devices

In this lecture, the methods of analysis, modeling, and parameter extraction for the characterization of electrical and optical properties in the semiconductor devices and their applications will be discussed in detail.

· Advanced Intelligent Semiconductor Devices

In this lecture, the current-voltage (I-V) characteristics, capacitance-voltage (C-V) characteristics of semiconductor devices, mainly focusing on the BJTs (bipolar

junction transistors) and MOSFETs (metal-oxide-semiconductor field-effect transistors) will be discussed as a basic element for implementing artificial intelligent. Non-ideal and secondary effects including the process-related phenomena in the BJTs and MOSFETs will be also discussed in this lecture.

· Measurement techniques for semiconductor materials and devices

In this lecture, the methods of measurement, analysis, and parameter extraction for the characterization of material, electrical and optical properties of the semiconductor materials and devices and their applications will be discussed in detail.

· Intelligent Semiconductor Convergence Engineering

For the next-generation semiconductor devices, we will discuss the properties of the emerging semiconductor materials. We will also discuss their applications to broad areas including sensors in this lecture.

· Intelligent Memory Devices

Intelligent Memory Devices covers types of memories, geometrical structure, operation principle, and high performance memoriws for promising semiconductor& display systems. In particular, material, fabrication process, device structure, and bias-dependent characteristics of intelligent memory devices are covered.

· Intelligent Semiconductor Device-Circuit Codesign

We will discuss the advanced and optimization methods of the advenced circuit system for novel intellignet semiconductor devices and evaluate the performance of the designed circuit system.

· Intelligent Semiconductor Process Technology

Understand the essential semiconductor process for intelligent semiconductor fabrication, and learn its principles and techniques. Understand the process and

principle of manufacturing intelligent semiconductor devices and drive circuits by learning the concept of a comprehensive process by connecting unit processes. The process design rules and layout concepts will be covered which are required when designing integrated circuits for the characteristics of manufactured semiconductor devices and processes, as well as the realization of intelligent semiconductors.

· Advanced Topics in Integrated Circuit

The current research trends and problems in modern CMOS VLSI design are discussed in this course. In modern very deep-submicron VLSI design, high-speed signaling and low power issues such as signal integrity, interconnect, power distribution, power consumption, and timing becomes important, as devices go scaled further down. This course aims to introduce the recent design techniques, the optimization algorithms, and the layout methodologies to solve the signaling and low power issues in modern very deep-submicron VLSI design.

· Mixed-Mode Integrated Circuits

Main subsystems of the mixed-mode integrated circuits, based on a standard CMOS process, will be discussed. Issues on the design of analog filters adopting switched-capacitor circuits, A/D converters, D/A converters, PLL (phase-locked loop) and DLL (delay-locked loop) will be studied in depth.

· Analog Integrated Circuit

Analog signal-processing chip design based on a standard CMOS process will be discussed in this lecture. In the first, the basic concept of analog signal-processing with various transformation techniques including the z-transform and the op-amp, which is a basic building block in the analog signal processing circuits, will be taught in detail. The concept of the switched-capacitor filter for accurate analog signal-processing and its application analog filters will be also considered in the lecture.

· Low-Power Integrated Circuit

Low power circuit technology is strongly required to enhance battery lifetime especially in portable devices such as mobile phone and notebook. This power consumption can be divided into two categories of the dynamic and static consumption. Recently developed logic families and clocking strategy to reduce the dynamic power consumption are discussed in this course. In addition, static-power reduction techniques using dynamic threshold-voltage scheme, power cut-off switch, and so on are covered.

· VLSI System

Digital circuit technology based on the standard CMOS process will be discussed in this lecture. The delta-sigma data converters adopting digital signal-processing theory, in order to achieve a very high resolution, will be intensively considered. For this purpose, a digital signal-processing, especially the multi-rate sampling frequency system, will be taught in depth. Various types of delta-sigma architectures, digital behavioral blocks and VLSI implementation will be also treated in the lecture.

· Application Specific Integrated Circuit Design

Analog and digital IC designs for a single-chip implementation of the application-specific integrated systems with signal processing, automatic control, artificial intelligence, and image processing.

· SoC Design

The methodology for the IP-based SoC (system-on a chip) design will be discussed in detail. The hardware-description languages of VHDL or Verilog-HDL as a basic design tool for the SoC design will be studied, and the synthesis of digital circuits, verification methods, an auto-placement and routing technique in the layout design will be taught in hand. Some standards for the coding guideline and mixed-mode specs will be also introduced.

· Memory-Circuit

Memory devices as a core semiconductor industry, specifically, a circuit design of

DRAM will be discussed in the lecture. The principle of the memory cells, cell-arrays, circuit technologies of various peripheral circuits incorporated in the row path, column path, and the performance enhancement strategy of the overall chip in the high-speed DRAMs, including SDRAM (synchronous DRAM) or DDR (dual-data rate) SDRAM, will be considered in detail.

· Intelligent Memory-Circuit Design

Memory devices as a core intelligent semiconductor, a circuit design of DRAM will be discussed in the lecture. The principle of the memory cells, cell-arrays, circuit technologies of various peripheral circuits incorporated in the row path, column path, and the performance enhancement strategy of the overall chip in the high-performance intelligent memory will be considered in detail.

· Neuromorphic Circuit

In this lecture, analog and digital integrated circuits and their design, which are essential for implementing neuromorphic technology that imitates the nervous system of animals, a type of intelligent semiconductor, are covered.

· Application of Intelligence Semiconductor Technology

Intelligent semiconductor technology has various application fields such as high-performance and low-power processors sensors and controllers and system interfaces. In order to apply the understanding of intelligent semiconductor technology to the industrial field, this lecture deals with the structure and various applications of intelligent semiconductor technology.

· Advanced Display Engineering

In Advanced Display Engineering, we cover specialized techniques for high-performance display systems. Based on a robust semisonductor devices and current display techniaues, In particular, integrated approach on material-device-circuit are investigated for large scale, high definition, and

intelligent display systems.

· Optical Properties of Semiconductor Device and Optical Devices

This lecture covers about the operation principle, design method, characteristic analysis and application of electric-optical conversion semiconductor devices for various semiconductor devices, including basic optical properties of semiconductor materials and considering the application to the optical interconnect.

· Display Semiconductor Device

This course deals with professional semiconductor technology knowledge to grow as an expert in the display industry. In particular, semiconductor materials, various thin-film transistors, and light emitting devices, which are key elements in implementing low-power/large-size/high-speed/high-speed/low-power displays, are covered.

· Display Circuits

This course deals with the introduction and structure of circuits for driving the latest displays such as LCD and OLED. Learn in-depth expertise on various display driving circuits such as T-CON, gate/data driver, shift register, gradation expression DAC and amplifier.

· Colloquium for Intelligent Semiconductors and Displays

In the Colloquium for Intelligent Semiconductors and Displays, experts and engineers specialized in intelligent semiconductor & display systems are invited. Every graduates students in the program is requried to resister and attend.

· Power Semiconductor Devices

Course work to understand LDMOS, DEMOS, and ultra high-voltage (higher than 700V) devices; structure, material properties, characteristics for practical applications.

· Power IC

Principles and techniques of design of power electronic circuits in BCD(Bipolar, CMOS, DMOS) process. Circuit issues and practical designs with focus on semiconductor for vehicles, household AC/DC converters, power supplies, and display drivers will be discussed.

· Liberal and Exploratory Research Works

Students are allowed to explore creative research topics, organize them as research projects, perform research works, and finally complete the projects as a form of technical papers or intellectual properties in a limited time of one semester.

· Research Ethics & Thesis Study

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

· Creation and Application of IT IP

This course provides the students in the field of electronics, information and

communication, and computer with the creation of IPR(intellectual property rights), information retrieval, writing patent application specifications, and answering to the refusal from the examiner concerning the patent application. Practical contents such as the basic writing of patent license contract for the technology transfer will be handled as well.

· How to Read and Write Technical Papers

For well-trained engineers in the field of semiconductor & display systems, it is necessary to accurately read, write, and present research results to other engineers in techanical forms. In this lecture, we train students timely and accurately wirite research result in a technical papers and obtain the intelluctual property for the creative research outputs.

· In-Memory Processors

In the conventional Von Neurmann computing structure, memory and logic blocks are separated from each other, which caused the problem of consuming a large amount of energy during frequent data exchange. To solve the problems, in-memory processing technology as a new computing structure has recently been receiving a lot of attention. This course provides learning on existing and new memory devices, in-memory processing circuit technology, and system application for in-memory processing, and learn about new computing hardware that overcomes the limitations of existing computing structures and reduces energy consumption.

· DTCO Design I

The performance of integrated circuits is deeply related to both semiconductor fabrication technology and circuit design, and performance can be optimized through design that takes into account the characteristics of both technologies. This course provides introductory learning on process technology and circuit design for semiconductor IC production, and teaches how to use device/design tools such as TCAD and Cadence. Through the courses, understand the integrated analysis theory of process technology, device physics, and circuit design.

· DTCO Design II

Analyze the relationship between process technology, device physics, and circuit design with logic gates and SRAM. Using device and circuit analysis and simulation tools such as TCAD and Cadence, the exercises will be conducted using logic gates and SRAM standard cells. Perform DTCO optimization design as a term project to understand design optimization considering process technology, device physics, and circuit design.

□ Faculty Members

Kim, Dong Myong
Seoul National Univ., B.S.
Seoul National Univ., M.S.
Univ. of Minnesota, Ph.D.
Semiconductor Devices and Integrated Circuits
dmkim@kookmin.ac.kr

Min, Kyeong Sik
Korea Univ., B.S.
KAIST, M.S.
KAIST, Ph.D.
Semiconductor and Integrated Circuits
mks@kookmin.ac.kr

Choi, Sung Jin
Chung-Ang Univ. B.S.
KAIST, M.S.
KAIST, Ph.D.
Semiconductor Devices and Integrated Circuits
sjchoiee@kookmin.ac.kr

Kim, Dae Jeong
Seoul National Univ., B.S.
Seoul National Univ., M.S.
Seoul National Univ., Ph.D.
Integrated Circuit Design
kimdj@kookmin.ac.kr

Kim, Dae Hwan
Seoul National Univ., B.S.
Seoul National Univ., M.S.
Seoul National Univ., Ph.D.
Semiconductor Devices and Integrated Circuits
drlife@kookmin.ac.kr

Bae, Jong Ho
POSTECH, B.S.
Seoul National Univ., M.S.
Seoul National Univ., Ph.D.
Semiconductor Devices and Integrated Circuits
jbae@kookmin.ac.kr

Mo, Hyun sun
Kookmin Univ., B.S.
Kookmin Univ., M.S.
Kookmin Univ., Ph.D.
Integrated Circuit Design
tyche@kookmin.ac.kr