

Integrated Circuit Science and Engineering

2022

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1. Overview of the Program

The *Integrated Circuit Science and Engineering* (ICSE) discipline at Beijing Institute of Technology (BIT) has a long history that can be traced back to 1960 when the major of Semiconductor Materials and Devices was founded as one of the oldest majors in Electronics and Devices in China. Over the past 60 years, The ICSE discipline at BIT has always insisted on educating fostering high-end and urgently-needed talents for the country. In 2016, BIT was selected to establish the National Demonstration School of Microelectronics as an exemplary model; then in 2021, BIT was approved to set up a doctoral site for the discipline of *Integrated Circuit Science and Engineering*. This is one of the first batch of doctoral programs for this discipline in China and also the first batch of universities selected for the National Integrated Circuit Projects aiming at educating high-level talents in a short supply. The ICSE discipline at BIT focuses on the key issues in the fields of Integrated Circuits and aims to fulfill the major strategic requirements of the country as well as to lead the world frontier in science and technology. Our ICSE also persists leading to an engineering-oriented road with the combination of production and research, which may serve for the national defense in the future. This also helps to form an interdisciplinary layout with the majors of electronics, materials, information, optics, etc., as well as a joint school-enterprise training program with industry leaders such as *Empyrean Technology Co., Ltd.*, *NAURA Technology Group Co., Ltd.*, the 6th *Research Institute of China Electronics and Piotech Inc.*

There are currently 90 full-time faculty in this discipline, including 33 professors and 37 associate professors. 80% of the faculty have overseas experience. In our faculty, there are two distinguished professors entitled with "Yangtze River Scholars", two professors entitled with "Outstanding Youth", one professor honored as the technological innovation leader, one professor honored with the High-level Overseas Project, one IEEE Fellow, and six national scholars in the High-level Youth Talent Project. In addition, there are also one faculty member honored as the "Famous Teacher" and one as the "Young Famous Teacher" in Beijing.

The discipline of *Integrated Circuit Science and Engineering* has high-level laboratories such as the Key Laboratory of Low-Dimensional Quantum Structures and Devices of the Ministry of Industry and Information Technology, the Beijing Key Laboratory of Millimeter Wave and Terahertz Technology, the Beijing Engineering Technology

Research Center for Silicon-based High-speed Systems on a Chip, the National Defense Key Discipline Laboratory of Multiple Information Systems and the National Demonstration Center for Electrical and Electronics Experimental Teaching. There are also school-local cooperation institutions built together with the local governments like the BIT Chongqing Center for Microelectronics and Microsystems, the Innovation Center of MEMS/NEMS Devices and Systems (Yangtze River Delta Graduate School) and so on. Until now, the total laboratory area is nearly 10,000 square meters and the total value of experimental equipment exceeds 100 million Yuan.

The discipline undertakes scientific research projects such as the National Key R&D Projects, the projects of National Natural Science Foundation of China, the Outstanding Youth Projects, the Excellent Youth Project, the major projects of the Science and Technology Commission of the Military Commission, and key projects of the Beijing Science and Technology Plan, with an average annual research funding of over 100 million Yuan. A series of international and domestic leading achievements have been made in the fields of new low-dimensional quantum structures and devices, intelligent MEMS micromirrors, special processing chips and system applications for spaceborne signals, etc. The discipline consists of four main research directions that are described below.

1) Integrated Micro-Nano Electronics Science

Aiming at the major strategic requirements of the country in the field of Integrated Circuits, *Integrated Micro-Nano Electronics Science* carries out research on low-dimensional electronic materials, extreme bandgap semiconductor materials like ultra-wide bandgap semiconductors, as well as the device construction based on these materials, including new concept devices, power semiconductor devices, long-wavelength and solar-blind detection devices, etc. The goal is to develop intelligent, lightweight, miniaturized and multi-functional integrated extreme bandgap semiconductor functional devices, as well as provide insights into their applications in the major national strategic fields such as power transmission, new energy vehicles, high-frequency communication, and intelligent perception. The direction aims at cultivating professionals in the direction of micro-nano electronics, therefore creating a special direction of *Integrated Micro-Nano Electronics Science* in BIT, as well as promoting the discipline of Integrated Circuits and its related fields.

2) MEMS and Integrated Microsystems

MEMS and Integrated Microsystems is dedicated to the design and fabrication of MEMS micro-nano sensors and actuators as well as microfluidic chips, featuring optical MEMS, acoustic MEMS, resonant MEMS, and the integration of CMOS-MEMS. It emphasizes on the joint interdisciplines of electronics, optics, acoustics, thermal and material science, and biology, aiming to develop intelligent, multi-energy-domain, lightweight, miniaturized, and integrated microsystems with multi-functions, which can be further applied in the major national strategic fields such as intelligent sensing, intelligent manufacturing, precision medicine, unmanned driving, intelligent environmental

protection, smart robots, remote sensing, and telemetry. This direction is aimed at cultivating high-quality engineers in the fields of *MEMS and Integrated Microsystems* and promoting the development of integrated circuits as well as the related disciplines.

3) Integrated Circuit Design and Advanced Packaging

To meet the major national requirements in the fields of new-generation radar information systems, low-orbit satellite Internet, and high-efficiency signal processing, *Integrated Circuit Design and Advanced Packaging* has been focusing on the following directions: the design methods and theory of integrated circuit, the design of analog and mixed-signal integrated circuit, the design and applications of silicon-based RF/millimeter wave integrated circuit, the system-on-chip (SOC) design. Aiming at major scientific issues such as new design theories, new functional devices, and new micro-nano systems for integrated circuits in the post-Moore era, the direction have been dedicated to the fields of three-dimensional vertical interconnection technology, transition board and heterogeneous integration technology, sensor-memory-computing integrated design technology, as well as basic and applied research on new forms of information devices. The goal is to feature advantages in the fields of millimeter-wave ASIC design, through-silicon via (TSV) complete process with small diameter, ultra-high aspect ratio and ultra-high depth, ultra-large-scale special signal processing chip design and application, special anti-irradiation chips for aerospace applications, etc.

4) Flexible Electronic Devices and Intelligent Manufacturing

Aiming at multiple bottlenecks faced by flexible electronic devices in terms of structure design, preparation of semiconductor materials, large-scale manufacturing technologies and development of special equipment, etc., *Flexible Electronic Devices and Intelligent Manufacturing* is dedicated to develop new structures, new functional devices and systems in the post-Moore era. Through the in-depth interdisciplinary of microelectronics, optoelectronics, quantum information, materials, mechanics, biomedicine, and artificial intelligence, etc., this direction aims to develop flexible intelligent robot perception (vision, touch, smell), bionic sensors and systems for precision medicine and personalized physiotherapy, as well as multifunctional flexible and wearable electronic systems. The goal is to cultivate professionals in the field of flexible electronics with an international perspective, and to develop Integrated Circuits and its related disciplines.

2. Training Target

- 1) To train students to understand the solid basic theory and systematic and specialized knowledge of the discipline, learn the modern experimental methods and skills of the discipline (direction), have an interdisciplinary academic background, and have the ability to engage in scientific research work or independently undertake specialized technical work in the field of Integrated Circuit Science and

Engineering.

- 2) To train high-level, innovative talents who have a good knowledge of international common sense, with the ability of spreading Chinese and foreign cultures occupied, so that to bring international graduate students into full play as a cultural bridge.

3. Length of Schooling

- 1) The basic length for master students is 2 years. In principle, students must complete the courses in the first academic year. Thesis work time must be at least one year. The maximum length of study for master students can be extended by 0.5 years on the basis of 2 years.
- 2) The basic length for Ph.D. students is 4 years. In principle, students must complete the courses in the first academic year. Thesis work time must be at least three years. The maximum length of study for Ph.D. students can be extended by 2 years at maximum on the basis of 4 years.

4. Curriculum and Credits Requirements()

Course Classification	Course Code	Course Name	Course Hours	Credits No	Semester	Compulsory/Optional	Master/Ph.D.	Credits Requirement
Public Courses	3700005	Chinese Language	96	6	1	Compulsory	Master/Ph.D.	Master=14 Ph.D.=14 =14
	3700006	Chinese Language	96	6	2	Compulsory	Master/Ph.D.	
	3700002	Outline of China	32	2	1/2	Compulsory	Master/Ph.D.	
Basic Courses	1701002	Matrix Analysis	32	2	1/2	Optional	Master/Ph.D.	Master 2 Ph.D. 2 2 2
	1701003	Science and Engineering Calculation	32	2	1/2	Optional	Master/Ph.D.	
	1701007	Modern Regression Techniques in Data Sciences	32	2	1/2	Optional	Master/Ph.D.	
Discipline Core Courses	1301004	Fundamentals of MEMS Transducers	32	2	1	Optional	Master/Ph.D.	Master 2 Ph.D. 2 2

	1301005	Microfabrication for IC and MEMS I	32	2	1	Optional k	Master /Ph.D. v	v u 2
	1301006	Nano-Electronic Devices and Applications d i	32	2	1	Optional k	Master /Ph.D. v	
Major Optional Courses F 3 k	0501004	Modern Antenna Theory and Technology q b	32	2	2	Optional k	Master	Master u 6 Ph.D. u 2 u 6 v u 2
	0501005	RF Circuit Design Theory and Application b	32	2	2	Optional k	Master	
	0501009	Foundation of FPGA and SoPC Design FPGA b SoPC	32	2	2	Optional k	Master	
	0501011	Multi-source Data Fusion Theory and Application "" b	32	2	2	Optional k	Master	
	0501014	Advanced Digital Communication H	32	2	1	Optional k	Master	
	0501021	Probability, Radom Process and Stochastic Geometry in Engineering à 3 v i i	32	2	1	Optional k	Master	
	0501022	Medical Image Processing and Artificial Intelligence M "E b,	32	2	1	Optional k	Master	

	1301019	Semiconductor Optoelectronics 半导体光电子学	32	2	2	Optional 选修	Master	
	1301021	Radar remote sensing and channel modeling 雷达遥感与信道建模	32	2	1	Optional 选修	Master	
	1301026	MEMS Design MEMS	32	2	2	Optional 选修	Master /Ph.D. √	
	1301027	Microfabrication of IC and MEMS II IC与MEMS微加工 II	32	2	2	Optional 选修	Master /Ph.D. √	
	1301028	Introduction to Biophotonics 生物光子学入门	32	2	1	Optional 选修	Master /Ph.D. √	
	1301029	Integrated Microsystems 集成微系统	32	2	2	Optional 选修	Master /Ph.D. √	
	1301030	Advanced MEMS -- Optical MEMS MEMS 高级 光学 MEMS	16	1	2	Optional 选修	Master /Ph.D. √	
	1301031	Advanced MEMS -- Acoustic MEMS MEMS 高级 声学 MEMS	16	1	2	Optional 选修	Master /Ph.D. √	
	1301032	Advanced MEMS -- BioMEMS MEMS 高级 生物 MEMS	16	1	2	Optional 选修	Master /Ph.D. √	
	1301033	Advanced MEMS -- CMOS MEMS Integration MEMS 高级 CMOS-MEMS 集成	16	1	2	Optional 选修	Master /Ph.D. √	
	1301034	Advanced MEMS -- Thermal MEMS MEMS 高级 热 MEMS	16	1	2	Optional 选修	Master /Ph.D. √	

	1301035	Advanced MEMS -- Inertial MEMS MEMS F í	16	1	2	Optional k	Master /Ph.D. √	
	1301036	Advanced MEMS -- Resonant MEMS MEMS F í	16	1	2	Optional k	Master /Ph.D. √	
Total Credits	Master √ 24 credits Ph.D. √ 20 credits √ 24 √ √ 20							

Notes f € E

1). Public Courses

(1) Chinese Language: Set by International Students Center of BIT. All international students must take this required course.

(2) Outline of China: Set by International Students Center of BIT. All international students must take this required course.

2) Basic Courses

If the mathematic courses listed in the chart can't meet the requirement, different Programs can set their own Basic Course.

3) Discipline Core Courses

Different Programs can set their own Discipline Core Course.

4) Major Optional Courses

International students should choose course from their own program or from other programs. Under the guidance of the supervisor, Master international students can take undergraduate courses if needed. Ph.D. international students can take undergraduate courses if needed.

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International Graduate Students need to participate in academic activities, academic lectures and academic conferences of their own fields. Giving oral speeches on academic conferences, whether on or off campus, are highly recommended.

5. Practice Part

1) Academic Activity (1 credits)

International Graduate Students need to participate in academic activities, academic lectures and academic conferences of their own fields. Giving oral speeches on academic conferences, whether on or off campus, are highly recommended.

2) Innovation Practice (1 credits)

International Graduate Students should take scientific research training and social practices during their training period, which should be carried-out and evaluated by supervisors.

6. The Dissertation Related Work

1. Literature Review & Opening Report 2. Mid-Term Evaluation 3. Dissertation Writing and Dissertation Pre-Defense for Ph.D. students 4. Thesis Defense 5. Degree Conferment

More Details can be found in *Regulations of Training Procedures for International Graduates of BIT*, *Regulations of Dissertation Pre-Defense for Ph.D. Students of BIT* and *Implementation Regulations on Academic Degree Conferrals of Beijing Institute of Technology*.

Time nodes of relevant procedure

The Dissertation	Master	Ph. D.
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Literature Review& Opening Report 论文开题报告	Before week 1 of the 3 rd semester 第3学期第1周之前	Before week 1 of the 5 th semester 第5学期第1周之前
Mid-Term Evaluation 中期考核	第3学期第1周之前	Before week 1 of the 7 th semester 第7学期第1周之前
Dissertation Pre-Defense 论文预答辩	第3学期第1周之前	Before Review 答辩前
Dissertation Defense 论文答辩	At least 9 months after the Opening Report 9个月之后	At least 18 months after the Opening Report 18个月之后
Degree Application 学位申请	The application should be raised in a certain time after the Dissertation Defense 答辩后一定时间内提出	

7. Course Syllabus

Course Code Course Name Class Hour Credits Course Description and Course Target Teaching Method
Evaluation and Exams Suitable Specialty Prerequisites Course Contents Reference.

课程代码 课程名称 学时 学分 课程描述及课程目标 教学方法
考核评价 适用专业 先修课程 课程主要内容 参考文献