**上海交通大学工程硕博士专项集成电路领域**

**2024级全日制博士研究生培养方案**

# 一、基本信息

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| **院系名称** | 机械与动力工程学院 | **适用年级** | 2024级 |
| **适用专业** | 机械、能源动力 | **基本学制** | 5年 |
| **适用领域** | 集成电路 | **联培企业** | 上海微电子装备集团 |
| **学位类型** | 专业型 | **学习形式** | 全日制 |
| **培养层次** | 直博生 |
| **最低学分** | 40 | **最低GPA学分** | 19 | **最低GPA** | 2.7 |

# 二、领域简介

工程硕博士专项集成电路领域依托上海微电子装备集团联合开展卓越工程师人才培养。

上海交通大学和上海微电子装备集团在共建实验室、联合技术研发等方面合作基础深厚。本专项旨在服务国家集成电路领域的急需发展需求，深入落实产教融合培养模式，在精密制造装备、精密作动技术、精密传感技术、振动控制技术等IC制造以及相关高端制造装备的关键技术方向，以及光刻机定位系统、环境控制系统、冷却系统、紫外光发生系统等涉及到流动传热、湍流光学、湍流噪声等多学科交叉方向，进一步加强校企协同创新，为我国集成电路领域核心技术突破培养和储备一批拥有深厚家国情怀、强烈责任担当，具备多学科背景知识、扎实专业素养及广阔国际视野，能够创造性解决集成电路领域关键科技问题、引领该领域科技创新发展的创新型人才！

The Doctoral program in integrated circuits is jointly developed by Shanghai Micro Electronics Equipment (Group) Co., Ltd. (SMEE), in collaboration with Shanghai Jiao Tong University.

Shanghai Jiao Tong University and SMEE have a strong foundation of cooperation in co-establishing laboratories and conducting joint technological research and development. This specialization aims to address the urgent developmental needs of the national integrated circuits sector, deeply implementing an industry-education integration training model. It focuses on key technological directions in IC manufacturing and related high-end manufacturing equipment, such as precision manufacturing equipment, precision actuation technology, precision sensing technology, vibration control technology, as well as interdisciplinary areas involving flow heat transfer, turbulent optics, and turbulent noise, such as lithography positioning systems, environmental control systems, cooling systems, ultraviolet light generation systems, etc. Further efforts are made to enhance university-enterprise collaborative innovation, nurturing and reserving a group of innovative talents in the field of integrated circuits. These individuals possess a deep sense of national pride and strong responsibility, with interdisciplinary knowledge, solid professional skills, and a broad international perspective. They are capable of creatively solving key technological problems in the integrated circuits field and leading technological innovation and development in this domain.

# 三、培养定位及目标

本专项聚焦国家重大战略需求、支撑产业链安全，围绕学校和企业研究生人才培养的总体目标，培养政治坚定、爱党报国、敬业奉献，数理基础坚实、知识结构宽广，专业领域知识精通、专业技术能力和水平突出，工程技术创新创造能力强，善于解决复杂工程技术难题，国际视野宽阔，扎根工程实践和生产一线的卓越工程师后备人才，能胜任高等教育专业教学、科学研究、技术研发和科技管理等工作。

学生毕业时应达到：

1、具有坚实的数理基础理论知识，宽广的机械或动力工程及相关专业基础知识，深入了解学科的进展、动向和领域最新发展前沿；

2、具有敏锐的洞察力，具备对工程科学及技术问题的深入理解和综合分析能力；

3、具有独立从事科学研究的能力，并在本学科领域的某一方面理论或实践上取得创造性研究成果；

4、至少精通一门外国语，能熟练地阅读本专业外文资料，具有较强的写作能力和国际学术交流的能力；

5、具备优秀的学术素养、职业道德和社会责任感。

The program focuses on the major strategic needs of the nation, and supports the security of industrial chain. It centers around the overall goal of graduate education for both universities and enterprises, aiming to cultivate outstanding engineering talents who are politically steadfast, dedicated to the party and the country, and committed to professionalism and dedication. These talents are expected to have a solid foundation in mathematics and science, broad knowledge structure, deep expertise in their professional fields, outstanding technical capabilities, and a strong ability to innovate and solve complex engineering challenges. They should possess a broad international perspective, rooted in engineering practice and front-line production, preparing them as reserve talents capable of excelling in higher education teaching, scientific research, technical development, and science and technology management.

Upon graduation, students are expected to achieve the following:

1. Having solid foundational theoretical knowledge in mathematics and physics, broad foundational knowledge in mechanical and power engineering and related fields, and a deep understanding of the progress, trends, and latest developments at the forefront of the discipline.

2. Having keen insight and the ability to deeply understand and comprehensively analyze engineering science and technical issues.

3. Demonstrating the capability to independently conduct scientific research and achieve creative research outcomes in theory or practice within a specific aspect of their field.

4. Being proficient in at least one foreign language, able to fluently read professional foreign-language materials, and possess strong writing skills and international academic communication abilities.

5. Exhibiting excellent academic quality, professional ethics, and a strong sense of social responsibility.

# 四、培养方式及学习年限

本专项为本科直博项目，采用全日制学习方式，基本学习年限为5年。未能按时完成学业者，经申请批准后其学习年限可适当延长，最长可以延期至七年。

本专项采取课程学习、专业实践、学位论文相结合的培养方式，施行校内导师及企业导师联合指导的导师负责制培养模式，由学校及企业共同承担培养工作，可依托在研合作科研项目、企业工程技术需求“揭榜挂帅”、企业在研项目开展联合培养。

培养环节包括学校培养阶段和企业培养阶段，按照“2+3”方式安排，即2年左右在学校完成课程学习及资格考试，3年左右在企业完成专业实践、学位论文工作。

This program is Direct-Entry-PhD and conducted on a full-time basis, with a basic study period of 5 years. Students who are unable to complete their studies on time may apply for an extension, with the maximum extension period approved being up to seven years.

The program adopts an integrated training approach combining coursework, professional practice, and thesis writing. It implements a mentor-ship system where university and enterprise mentors jointly guide students. Both the university and enterprises collaborate to undertake the training, leveraging collaborative research projects, enterprise engineering and technical needs, and joint training through ongoing enterprise projects.

The training program includes a university phase and an enterprise phase, arranged in a “2+3” model. This means spending approximately 2 years at the university to complete coursework and qualifying exams, followed by about 3 years at the enterprise for professional practice and dissertation work.

# 五、课程学习要求

课程总学分≥40学分，总学分上限为60学分。其中GPA统计源的课程≥19学分，必须选择一门全英文课程。GPA≥2.7方可以进行后续培养过程。

1、公共基础课，14.5学分：

1）MARX7001 中国马克思主义与当代，2学分，必修

2）MARX6003 自然辩证法概论，1学分，必修

3）FL6001 学术英语，2学分，必修

4）GE6001 学术写作、规范与伦理，1学分，必修，院系开课

5）MEM6002工程管理导论，2学分，必修，院系开课

6）GE6003 实验室安全教育，0.5学分，必修，院系开课，不可计入GPA

7）数学课，6学分，必修

2、专业选修课：公共前沿选修课，至少1学分，必修

3、专业前沿课：

1）GE6011 学术报告会，1学分，必修，不可计入GPA

2）GE9003 工程实践I，1学分，必修，不可计入GPA

3）工程师素养类课程，GE6004钱学森系统工程思想导论（1学分）、LAW6942工程师与知识产权（2学分）、DES9006创新设计思维（1学分），zzb专项领域的学生至少修1门

4）工程前沿技术类课程，以校企共建、案例实践课程为主，各院系校企合作课程共享，其中超精密光学制造技术为本领域机械专业的基地学生必修、光刻流体力学为本领域能源动力专业的基地学生必修

# 六、培养过程要求

**(一) 校企导师组指导：**

采用校内导师及企业导师构成的校企导师组指导制度，共同就研究生的课程学习、专业实践、学术成果、学位论文等提供切实有效的指导。

校内导师，重点负责指导基地研究生的课程学习、学术成果及学位论文涉及的科学研究内容等。

企业导师，重点负责指导基地研究生的专业实践、学术成果及学位论文涉及的工程实践内容等。

**(二) 培养过程环节要求：**

**1、资格考试**：原则上应在第4学期结束前完成（含补考）。资格考试通过后方可申请开题。两次资格考试不通过者，经学院审议后进入分流淘汰程序。

由学院组织，考试形式包括笔试（闭卷）和面试，考试内容为3门专业基础课。

**2、开题报告**：一般应在第5学期结束前完成，不晚于第6学期前进行。开题报告要求就学位论文选题的科学根据、目的意义、研究内容、预期目标、研究方法和课题条件等做出论证。开题报告的文献阅读量应不少于50～100篇。

工程博士研究生应根据企业工程技术实践项目开展学位论文选题。拟开展的学位论文研究应具有理论深度和先进性，拟解决的问题要有较大的技术难度和饱满的工作量，体现研究生综合运用科学理论、方法和技术手段解决工程技术问题的能力，研究成果要有重要的实际应用价值和较好的推广价值。选题范围主要涵盖（不限于）以下方面：1）技术攻关、技术改造、技术推广与应用；2）新工艺、新材料、新产品、新设备的研制与开发；3）引进、消化、吸收和应用国外先进技术项目；4）工程技术项目的规划或研究；5）工程设计与实施；6）技术标准制定；7）其他同等水平的工程应用类研究。

由学院及企业联合组织。首次开题不通过者，可申请二次开题；两次开题均不通过者，经学院审议后进入分流淘汰程序。

**3、年度考核**：开题报告通过后，每自然年进行一次，由学院及企业联合组织。最晚在第8学期结束前完成首次年度考核。开题报告通过不满半年者可不参加当年年度考核。未按期在第8学期结束前完成首次年度考核者，第9学期起不予以注册，且导师记录博士生培养负面清单1次。

**4、专业实践**：博士生须在导师组指导下，紧密结合企业生产一线研发任务开展，制定专业实践工作计划，撰写专业实践总结报告。原则上应于第4学期末提交《专业实践工作计划》。专业实践应体现所解决工程问题的成效，包括工程技术的难易程度和工作量。专业实践结束后撰写《专业实践总结报告》，须有专业实践单位的考核评价意见以及导师组的审核意见，经学院组织考核通过后，取得相应学分。专业实践须

专业实践实行工学交替模式，研究生在企业专业实践期间，根据需要也可返校与学校导师、同学交流研讨实践项目进展，查阅图书文献，利用学校科研平台、仪器设备进行补充研究等，校企同城的可利用周末返校，校企不同城的每学期可返校2周左右。

**5、预答辩**：通过年度考核后、正式答辩前的三个月可提出预答辩申请。预答辩不通过者不能进入后续博士学位申请流程。

**6、论文答辩**：在第10学期前完成（鼓励条件成熟情况下尽早完成，但不早于第8学期），未完成者最多可延期至14学期。答辩由学科及企业组织，论文评阅与答辩委员会专家组成应至少需要5位，其中企业专家占半数以上。答辩前将由学院督导进行形式审查，对发表小论文不合格、盲审成绩过低等情况将不予审核通过。

**(三) 学术写作与交流要求**

1、至少精通一门外国语，能熟练地阅读本专业外文资料，具有较强的写作能力，须有以排序第一作者在国际重要学术期刊或高水平国内期刊发表与博士学位论文研究工作密切相关的研究性学术论文的经历。国际重要学术期刊和高水平国内期刊的具体认定办法详见七“学术成果要求”。

2、应具备国际学术交流的能力，在读期间必须在高水平国内外学术会议上以口头报告形式开展学术交流至少1次，且学术交流的内容须与博士学位论文研究工作密切相关。交流形式等具体要求详见《上海交通大学关于博士研究生参加学术交流的规定》。高水平国内外学术会议的具体认定办法详见详见七“学术成果要求”。

**(I) Guidance by University-Enterprise Mentor-ship Group:**

Utilizing a mentor-ship system composed of both university and enterprise mentors, the university-enterprise mentor-ship group provides practical and effective guidance on graduate students' course study, professional practice, academic achievements, and thesis writing.

* **University mentors** primarily guide graduate students in coursework, academic achievements, and scientific research content related to their thesis.
* **Enterprise mentors** focus on guiding graduate students in professional practice, academic achievements, and engineering practical content related to their thesis.

**(II) Requirements for Training Process Stages:**

**1. Qualifying Examination:** The qualifying examination should ideally be completed by the end of the 4th semester (including re-exams). Upon passing the qualifying examination, students may apply for thesis proposal. Students who fail the qualifying examination twice will enter a review process conducted by the college.

 The examination is organized by the college and includes written (closed-book) and oral components, covering three core courses.

**2. Thesis Proposal:** Generally, the thesis proposal should be completed by the end of the 5th semester and no later than the beginning of the 6th semester. The thesis proposal should provide a scientific basis for the chosen thesis topic, including its rationale, research content, expected objectives, research methods, and necessary conditions. The literature review for the thesis proposal should encompass no less than 50-100 articles.

Engineering doctoral candidates should base their thesis topics on enterprise engineering technical practice projects. The proposed thesis research should demonstrate theoretical depth and innovation, addressing significant technical challenges and requiring substantial effort. It should showcase the candidate's ability to apply scientific theory, methods, and technological means to solve engineering problems, with resulting research outcomes demonstrating significant practical and promotional value. The scope of thesis topics primarily includes (but is not limited to) the following areas: 1) Technological breakthroughs, technological upgrades, and applications; 2) Development of new processes, materials, and equipment; 3) Introduction, digestion, absorption, and application of advanced foreign technologies; 4) Planning or research of engineering technology projects; 5) Engineering design and implementation; 6) Development of technical standards; 7) Other engineering application research of equivalent level.

This process is jointly organized by the college and enterprises. Candidates who do not pass the initial thesis proposal may apply for a second attempt; those who fail both attempts will be reviewed by the college for further action.

**3.** **Annual Assessment:** Upon passing the thesis proposal and annual assessment, which is jointly organized by the college. Completion of studies should be no later than the end of the 8th semester. Failure to complete studies by the designated time will result in consequences as outlined by the college.

**4.** **Professional Practice:** Doctoral students must, under the guidance of the advisor team, closely integrate with front-line enterprise production and R&D tasks, develop a professional practice work plan, and write a summary report on professional practice. In principle, the professional practice work plan should be submitted by the end of the fourth semester. The professional practice should reflect the effectiveness of solving engineering problems, including the difficulty level and workload of engineering technology. After completing the professional practice, a "Professional Practice Summary Report" must be written, which should include the assessment opinions of the professional practice unit and the review opinions of the advisor team. After assessment organized by the college, corresponding credits are awarded. The professional practice should follow an alternating pattern of academic and industrial practice. During the enterprise professional practice period, students may return to campus as needed to discuss project progress with school advisors and classmates, access library resources, utilize research platforms, and use equipment for supplementary research. For students in the same city as the enterprise, weekends can be utilized for campus visits, while for those in different cities, visits of approximately two weeks per semester are allowed.

**5.** **Pre-defense:** Three months before the formal defense and after passing the annual assessment, students may apply for a pre-defense. Failure in the pre-defense disqualifies students from proceeding with the subsequent doctoral degree application process.

**6. Thesis Defense:** Should be completed by the end of the tenth semester (encouraged to complete earlier if conditions permit, but not earlier than the eighth semester). Students who fail to complete it by this time may request an extension, up to a maximum of the fourteenth semester. The defense is organized by the discipline and enterprises. The thesis evaluation and defense committee should consist of at least 5 experts, with more than half being industry experts. Prior to the defense, a formal review will be conducted by college supervisors, and failure to meet criteria such as inadequate publication of small papers or low scores from blind reviews will result in disqualification from the review process.

**(III)** **Academic Writing and Communication Requirements:**

1. Proficiency in at least one foreign language, capable of proficiently reading foreign literature in the field, and possessing strong writing skills. Must have experience publishing research papers closely related to doctoral dissertation research as the first author in internationally recognized academic journals or high-level domestic journals. Specific criteria for identifying internationally recognized academic journals and high-level domestic journals are detailed in Section Seven "Requirements for Academic Achievements."

2. Ability to engage in international academic exchanges. During the doctoral program, it is mandatory to present academic papers at least once in oral presentation format at high-level domestic and international academic conferences. The content of these exchanges must be closely related to the research work of the doctoral dissertation. Specific requirements for the format of exchanges are detailed in the "Regulations of Shanghai Jiao Tong University on Participation of Doctoral Students in Academic Exchanges." Detailed criteria for identifying high-level domestic and international academic conferences are also outlined in Section Seven "Requirements for Academic Achievements."

# 七、学术成果要求

博士学位论文的创新成果是评价学位论文水平的重要参考，必须是以学位申请人为主在攻读博士学位期间取得，且与学位论文内容密切相关。

用于申请博士学位的学位论文中必须包含不少于三项以申请人为主要完成人的创新性成果。创新性成果的主要完成人一般应为成果第一完成人，如果第一完成人是申请人的博士生导师且申请人排序第二，则申请人也认定为主要完成人。创新性成果原则上应以上海交通大学为第一完成单位。

博士学位论文的创新性成果应该具有重要的理论或工程应用价值，具体展现形式包括：

（1）发表在国际重要学术期刊或高水平国内学术期刊上的研究性学术论文。其中，国际重要学术期刊是指SCI刊源期刊，但不包含按《机械与动力工程学院不推荐SCI期刊认定办法》认定的不推荐期刊；高水平国内期刊是指《高质量科技期刊分级目录》相关领域T1/T2档核心期刊。国际重要学术期刊与高水平国内期刊均以论文发表或录用当年为准认定。

（2）发表在高水平国内外学术会议的会议论文或者口头报告且能提供相应证明材料。高水平国内外学术会议包括本学科公认的国内外学术组织主办的系列专业性学术会议或《上海交通大学资助研究生参加国际会议项目-重要国际会议目录》中的会议。口头报告需提供会议录用摘要证明。如果学术会议论文或口头报告学术贡献与发表期刊论文相同，则认定为一项成果。

（3）获得授权的重要发明专利且能提供相关实施应用证明材料。

（4）由中国国家标准管理委员会正式发布国家标准，或由ISO、IEEE、ASME等国际组织发布的国际标准，及相关行业归口部门统一管理发布的行业标准。

（5）由学院学位评定委员会委员和同行专家组成的专家组，或有关权威组织机构认定的其他重大成果。

具体详见《上海交大机械与动力工程学院博士学位（专业型）授予标准》，对达不到创新性成果要求的博士生，将无法进入正式答辩。

The innovative achievements of doctoral dissertations are critical for assessing the level of the dissertation and must be primarily achieved by the doctoral candidate during their pursuit of the doctoral degree, closely related to the dissertation content.

A dissertation submitted for a doctoral degree application must include no fewer than three innovative achievements where the applicant is the principal contributor. The primary contributor to the innovative achievement should generally be listed as the first author. If the first author is the applicant's supervisor and the applicant is listed as the second, the applicant is still considered a principal contributor. Innovative achievements should primarily be affiliated with Shanghai Jiao Tong University.

The innovative achievements of doctoral dissertations should have significant theoretical or engineering application value. Specific forms of demonstration include:

(1) Publishing research academic papers in internationally significant academic journals or high-level domestic academic journals. International significant academic journals refer to SCI source journals, excluding those identified as not recommended according to the "Mechanical and Power Engineering College's Non-Recommended SCI Journal Identification Method." High-level domestic journals refer to T1/T2 core journals in relevant fields listed in the "High-Quality Science and Technology Journal Classification Catalog." Recognition is based on the year of publication or acceptance of the paper.

(2) Presenting conference papers or oral reports at high-level domestic and international academic conferences and providing corresponding proof materials. High-level domestic and international academic conferences include series of specialized academic conferences hosted by internationally recognized academic organizations in the field or conferences listed in the "Shanghai Jiao Tong University Graduate Students' Participation in International Conference Projects - Important International Conference Directory." Oral presentations require conference abstracts as proof. If academic conference papers or oral presentations contribute similarly to published journal papers, they are considered one achievement.

(3) Obtaining authorized significant invention patents and providing relevant implementation proof materials.

(4) Formal release of national standards by the Chinese National Standards Management Committee, or international standards published by ISO, IEEE, ASME, and industry standards managed and published by relevant industry departments.

(5) Other major achievements recognized by the College's Degree Evaluation Committee and peer expert groups or relevant authoritative organizations.

For specific details, refer to the "Shanghai Jiao Tong University School of Mechanical Engineering and Power Engineering Doctoral Degree (Professional) Award Standards." Doctoral students who fail to meet the requirements for innovative achievements will not be eligible for formal defense.

# 八、学位论文

学位论文是进行学位评定的主要依据，应能反映出作者在本学科上已掌握坚实宽广的基础理论、系统深入的专门知识和规范科学的研究方法。

**1、选题与综述**

博士学位论文的选题应在本学科及相关领域具有开拓性、前沿性和创新性，应对经济建设和社会发展具有较大的理论意义或应用价值。

文献综述应在全面搜集、阅读大量有关研究文献的基础上，经过归纳整理、分析鉴别，对所研究的问题在一定时期内已经取得的研究成果、存在问题以及新的发展趋势等进行系统、全面、客观的叙述和评论，为论文课题的确立提供支持和论证。

**2、规范性要求**

博士学位论文必须是一篇系统、完整的学术论文，是学位申请者在攻读博士学位期间在导师指导下独立完成的研究成果，应严格遵守《上海交通大学研究生学术规范》和《机械与动力工程学院研究生学术道德规范》进行学位论文工作。

博士学位论文的学术观点必须明确，立论正确，推理严谨，数据真实，图表规范，层次分明，语言准确，文字通畅。

学位论文撰写必须遵循和符合《机械与动力工程学院学位论文撰写指南》的具体要求。

A doctoral dissertation serves as the primary basis for degree assessment, reflecting the author's comprehensive grasp of solid foundational theories, systematic in-depth specialized knowledge, and standardized scientific research methods within their discipline.

**1. Topic Selection and Literature Review**

The topic of a doctoral dissertation should be pioneering, cutting-edge, and innovative within the discipline and related fields, with significant theoretical or practical implications for economic and social development.

The literature review should be based on comprehensive collection and extensive reading of relevant research literature. It involves summarizing, organizing, analyzing, and critically evaluating the research outcomes, existing issues, and emerging trends related to the studied problems over a certain period. This systematic, comprehensive, and objective description and critique provide support and justification for establishing the thesis topic.

**2.** **Normative Requirements**

A doctoral dissertation must be a systematic, complete academic paper, representing independent research conducted by the degree applicant under the guidance of their supervisor(s). It should strictly adhere to the "Academic Norms for Postgraduates of Shanghai Jiao Tong University" and the "Academic Ethics Standards for Graduate Students of the School of Mechanical Engineering." The academic viewpoints in the doctoral dissertation must be explicit, logically sound, rigorously reasoned, based on truthful data, and presented with clear and standardized figures and tables. The structure should be well-organized, language precise, and text fluent.

The writing of the dissertation must follow and comply with the specific requirements outlined in the "Guidelines for Writing Doctoral Dissertations of the School of Mechanical Engineering."

# 九、课程设置

详见课程汇总一览表。