

MSc Analogue and Digital Integrated Circuit Design

This document provides a definitive record of the main features of the programme and the learning outcomes that a typical student may reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities provided. This programme specification is intended as a reference point for prospective students, current students, external examiners and academic and support staff involved in delivering the programme and enabling student development and achievement.

Programme Information

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|--|---|----|-------|-----|
| Award(s) | MSc | | | |
| Programme Title | Analogue and Digital Integrated Circuit Design | | | |
| Programme Code | H6W8 | | | |
| Awarding Institution | Imperial College London | | | |
| Teaching Institution | Imperial College London | | | |
| Faculty | Faculty of Engineering | | | |
| Department | Department of Electrical and Electronic Engineering | | | |
| Associateship | City and Guilds of London Institute (ACGI) | | | |
| Mode and Period of Study | 1 academic year full-time | | | |
| Cohort Entry Points | Annually in October | | | |
| Relevant QAA Benchmark Statement(s) and/or other external reference points | Master's Degree in Engineering | | | |
| Total Credits | ECTS: | 90 | CATS: | 180 |
| FHEQ Level | Level 7 | | | |
| EHEA Level | 2 nd cycle | | | |
| External Accrator(s) | The Institution of Engineering and Technology (IET) | | | |

Specification Details

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|--|------------------------------------|
| Student cohorts covered by specification | 2016/17 entry |
| Person responsible for the specification | Dr Christos Bouganis, MSc Director |
| Date of introduction of programme | 1996/97 |
| Date of programme specification/revision | September 2016 |

Description of Programme Contents

This degree provides future integrated circuit (IC) designers with in-depth knowledge of analogue, mixed signal and digital circuits. The aim is to provide experience in both the practical issues of device-level design and system-level performance requirements.

A key feature of this programme is the balanced approach to both analogue and digital IC design, and the in-depth treatment of low power circuits and embedded systems.

The programme covers issues that are related to digital system design using modern programming languages, to embedded systems and their OS, to the design of high performance systems based on GPUs and FPGAs, to the design of low power and high performance analogue circuits, as well as issues related to communication of systems (optical and RF) and to MEMS and nanotechnology.

Learning Outcomes

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/students/academic-support/graduate-attributes

Knowledge and Understanding of:

1. Fundamental principles of analogue circuit design;
2. Fundamental principles of digital integrated circuit design;
3. Modern methods of analogue integrated circuit design;
4. Modern methods of digital integrated circuit design;
5. Signal processing mathematics;
6. Integrated circuit manufacturing technologies;
7. Effective use of computer aided design (CAD) tools to augment analysis and support synthesis;
8. Research methods:
 - Literature search
 - Report writing
 - Presentation skills

Intellectual Skills

- Apply behavioural modelling on systems and specifications;
- Perform hierarchical abstractions during analysis and synthesis;
- Integrate and evaluate information from a variety of sources;
- Formulate and test hypotheses;
- Be creative in the solution of problems and in the development of hypotheses;
- Plan, conduct and write-up a programme of original research.

Practical Skills

- Design analogue circuits by hand and by using Computer Aided Design tools;
- Design digital circuits using hardware description languages;
- Use laboratory equipment to generate data;
- Analyse experimental results and determine their strength and validity;

- Prepare technical reports;
- Give Technical Presentations;
- Use the scientific literature effectively.

Transferable Skills

- Communicate effectively through oral presentations, computer processing and presentations, written reports and scientific publications;
- Apply modelling skills;
- Apply management skills: decision processes, objective criteria, problem definition, project design and evaluation, risk management, teamwork and coordination, extension needs;
- Integrate and evaluate information from a variety of sources;
- Transfer techniques and solutions from one discipline to another;
- Use Information and Communications Technology;
- Manage resources and time;
- Learn independently with open-mindedness and critical enquiry;
- Learn effectively for the purpose of continuing professional development.

Entry Requirements

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|---|--|
| Academic Requirement | A high first class (1st) Honours degree (75%+) in electrical engineering or a related subject. |
| Non-academic Requirements | N/A |
| Candidates may be required to attend an interview | |
| English Language Requirement | IELTS 6.5 with a minimum of 6.0 in each element or equivalent |

The programme's competency standards document can be found at: <http://www.imperial.ac.uk/electrical-engineering/study/undergraduate/applicants-with-disabilities/>

Learning & Teaching Strategy

| | |
|--|--|
| Scheduled Learning & Teaching Methods | <ul style="list-style-type: none"> • Lectures • Labs • Coursework • Group projects |
| E-learning & Blended Learning Methods | <ul style="list-style-type: none"> • Blackboard |
| Project and Placement Learning Methods | <ul style="list-style-type: none"> • Weekly meetings with the supervisor • Research project |

Assessment Strategy

| | |
|--------------------|---|
| Assessment Methods | <ul style="list-style-type: none"> • Examinations • Coursework • Practical |
|--------------------|---|

Academic Feedback Policy

Feedback to all submitted coursework is expected within two weeks

Mechanisms for providing prompt feedback to students on their performance in course work and examinations and processes for monitoring that these named processes are effective:

- All coursework is promptly marked
- Meeting of individual students with course directors to discuss exams, research project and career aims
- General remarks are communicated by broadcast emails to all Course students
- More details given to representatives in the Staff – Student Committee
- Course questionnaire evaluation of taught components

Re-sit Policy

The College's Policy on Re-sits is available at: <http://www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/>

Mitigating Circumstances Policy

The College's Policy on Mitigating Circumstances is available at: <http://www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/>

Assessment Structure

Marking Scheme

The Pass Mark for all **postgraduate** taught course modules is 50%. Students must pass all elements in order to be awarded a degree.

Final Degree Classifications

An MSc degree will be awarded to students obtaining:

- at least 40% for each of the 8 modules counted for the computation of the examinations average
- at least 50% for the laboratory work average
- at least 50% for both the project and examinations average

MSc degree with **merit** will be awarded to students obtaining

- at least 40% for each of the 8 modules counted for the computation of the examinations average
- at least 50% for the laboratory work average
- at least 60% for both the project and examinations average

MSc degree with **distinction** will be awarded to students obtaining

- at least 40% for each of the 8 modules counted for the computation of the examinations average
- at least 50% for the laboratory work average
- at least 70% for both the project and examinations average

Module Weightings

| Module | % Module Weighting |
|--|--------------------|
| Analogue Integrated Circuits and Systems | N/A |
| Full-Custom Integrated Circuit Design | N/A |
| Advanced Digital System Design | N/A |
| Analogue Signal Processing | N/A |
| A1 Lab | N/A |
| 4 modules from elective group (A)* | N/A |
| Individual Research Project | N/A |

***Please note that if you opt to take five modules from elective group (A), only the best four modules will be included when calculating the final degree classification.**

| Indicative Module List | | | | | | | | | | | |
|------------------------|---|-------------------|--------------|------------------------|-------------------------|----------------|----------------------|----------------------|----------------|---------------|------|
| Code | Title | Core/ Elective | L&T Hours | Ind. Study Hours | Place- ment Hours | Total Hours | % Written Exam | % Course- work | % Practical | FHEQ Level | ECTS |
| EE9-AC1 | Analogue Integrated Circuits and Systems | CORE | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AC3 | Full-Custom Integrated Circuit Design | CORE | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO16 | Advanced Digital System Design | CORE | 20 | 105 | 0 | 125 | 0% | 100% | 0% | 7 | 5 |
| EE9-AC6 | Analogue Signal Processing | CORE | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-ALAB | A1 Lab | CORE | 30 | 220 | 0 | 250 | 0% | 100% | 0% | 7 | 10 |
| EE9-AO2 | Digital Signal Processing and Digital Filters | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO3 | Advanced Computer Architecture | ELECTIVE (A) | 20 | 105 | 0 | 125 | 85% | 15% | 0% | 7 | 5 |
| EE9-AO4 | High Performance Analogue Electronics | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO6 | Radio Frequency Electronics | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO8 | Advanced Electronic Devices | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO9 | Optical Communication | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO11 | MEMS and Nanotechnology | ELECTIVE (A) | 20 | 105 | 0 | 125 | 100% | 0% | 0% | 7 | 5 |
| EE9-AO12 | Microwave Technology | ELECTIVE (A) | 20 | 105 | 0 | 125 | 80% | 20% | 0% | 7 | 5 |
| EE9-AO13 | Instrumentation | ELECTIVE (A) | 20 | 105 | 0 | 125 | 0% | 100% | 0% | 7 | 5 |

| Indicative Module List | | | | | | | | | | | |
|------------------------|--|-------------------|--------------|------------------------|-------------------------|----------------|----------------------|----------------------|----------------|---------------|------|
| Code | Title | Core/ Elective | L&T Hours | Ind. Study Hours | Place- ment Hours | Total Hours | % Written Exam | % Course- work | % Practical | FHEQ Level | ECTS |
| EE9-AO14 | High Performance Computing for Engineers | ELECTIVE (A) | 20 | 105 | 0 | 125 | 0% | 100% | 0% | 7 | 5 |
| EE9-APRJ | Individual Research Project | CORE | 0 | 1000 | 0 | 1000 | 0% | 85% | 15% | 7 | 40 |

Supporting Information

The Programme Handbook is available at:

<http://www.imperial.ac.uk/electrical-engineering/study/current-students-course-handbook/#m>

The Module Handbook is available at:

http://intranet.ee.ic.ac.uk/electricalengineering/eecourses_t4/crslistpg.asp?c=A1

The College's entry requirements for postgraduate programmes can be found at:

www.imperial.ac.uk/study/pg/apply/requirements

The College's Quality & Enhancement Framework is available at:

www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance

The College's Academic and Examination Regulations can be found at:

<https://www.imperial.ac.uk/about/governance/academic-governance/regulations>

Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine".

<http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters-statutes-ordinances-and-regulations/>

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<http://www.hefce.ac.uk/reg/register/>