## Communications and Signal Processing MSc Programme Specification

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. The latest version of this Programme Specification is available on [http://www3.imperial.ac.uk/electricalengineering/teaching/msc/comms](http://www3.imperial.ac.uk/electricalengineering/teaching/msc/comms). The Communications and Signal Processing MSc Welcome Booklet will be distributed to MSc students when they arrive and is available on-line to staff and relevant students by following the above web link. The accuracy of the information contained in this document is reviewed by Imperial College London and may be checked by the Quality Assurance Agency.

### 1. Awarding Institution / Body
- Imperial College London

### 2. Teaching Institution
- Imperial College London

### 3. External Accreditation by
- Not applicable

### 4. Final Award
- MSc

### 5. Programme Title
- Communications and Signal Processing

### 6. UCAS Code (or other coding system if relevant)
- H640

### 7. Relevant QAA Subject Benchmarking Group(s)
- Engineering

### 8. Date of production/revision
- September 2015

### 9. Educational Aims of the Programme

The programme is intended to:

- provide the theoretical basis for the analysis and design of communications and signal processing systems;
- provide practical experience in selected areas of communications and signal processing systems and in relevant selected tools, equipment and software;
- develop problem analysis skill and create opportunities for scientific creativity in problem solving;
- provide an opportunity to develop more independent learning and intellectual maturity through addressing significant challenges, both intellectual and practical;
- provide a supportive learning environment that includes training in relevant laboratory and research skills;
- give an appreciation of the breadth of application areas for communications and signal processing technology through access to a wide range of teaching provision and an active research environment;
- provide a solid background to enable graduates to independently update their knowledge and assist graduates wishing to undertake research in or involving communications and/or signal processing research topics.

### 10. Programme Outcomes

This programme provides opportunities for postgraduate students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas.

#### Knowledge and understanding

<table>
<thead>
<tr>
<th>Knowledge and understanding of:</th>
<th>Teaching / learning methods and strategies</th>
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<tbody>
<tr>
<td>1. fundamental and advanced principles of digital signal processing;</td>
<td>Participation in a combination of lectures, seminars, computer-based work, coursework and guided reading.</td>
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<tr>
<td>2. fundamental and advanced principles of communications;</td>
<td>Involvement in Industry driven individual research project</td>
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<tr>
<td>3. contemporary analytical methods of digital signal processing and communications systems;</td>
<td>Attendance and participation in a number of (GSEPS) skills workshops</td>
</tr>
<tr>
<td>a wide variety of specialised topics as represented in optional course modules and variety of dissertation projects;</td>
<td>Facilitate and encourage independent search and selection of relevant technical literature both to supplement and consolidate material relevant to the lectures and project, and to broaden their individual knowledge and understanding of the topic area under research/learning.</td>
</tr>
<tr>
<td>4. effective use of computer-based simulation tools and hardware-based test equipment</td>
<td>Assessment of the acquired knowledge is based on a combination of unseen written examinations and assessed coursework, as well as the individual research project.</td>
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<tr>
<td>5. research methods, including literature search, report writing, presentation skills;</td>
<td></td>
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<tr>
<td>project management and communication skills including problem definition, project design, execution and reporting.</td>
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</table>
Skills and Other Attributes

B. Intellectual (thinking) skills - able to:
1. develop model-based thinking for systems and specifications;
2. perform hierarchical abstractions during analysis and synthesis;
3. integrate and evaluate information from a variety of sources, and apply theoretical foundations and practical constraints to solve communications and/or signal processing problems;
4. formulate and test hypotheses be creative in the solution of problems and in the development of hypotheses;
5. plan, conduct and write-up a programme of original research.

Teaching/learning methods and strategies
Intellectual skills are developed through the teaching and learning methods previously outlined.

Team work is also required to carry out the laboratory experiments. Assessment is through coursework, closed book written examinations and project dissertation.

C. Practical skills – able to:
1. analyse and design digital signal processing systems and communication systems;
2. employ appropriate software tools and/or hardware test equipment in the design of digital signal processing circuits and communication systems;
3. use laboratory equipment to generate data;
4. analyse experimental results and determine their strength and validity;
5. prepare technical reports including the main individual project dissertation;
6. produce poster and deliver technical presentations;
7. use the scientific literature effectively.

Teaching/learning methods and strategies
Practical skills are developed through the teaching and learning programme previously outlined.

Practical computational skills are developed through coursework and project work and through interaction with research supervisor(s) and occasionally with research associates and students.

Some of these skills are taught and developed through guided reading and (GSEPS) workshops and practice, with feedback, associated with the individual dissertation.

Practical skills are assessed where appropriate through the coursework and project work.

D. Transferable skills – able to:
1. communicate effectively, as a result of clear and precise thinking, using presentations and written reports;
2. apply know-how and skills previously obtained to new problems;
3. formulate problem definitions and evaluate solutions using objective criteria;
4. integrate and evaluate information from a variety of sources;
5. figure out how techniques and solutions from one research discipline could be transferred to another research discipline;
6. use ICT technologies effectively and appropriately;
7. manage resources and time;
8. learn independently with open-mindedness and critical enquiry;
9. learn effectively for the purpose of continuing professional development.

Teaching/learning methods and strategies
Transferable skills are developed through the teaching and learning programme offered by (GSEPS) workshops and feedback on individual project work.

The course is designed with staged coursework deadlines and the examination system.

Assessment carried out through written examinations, course work and the individual project work.

Individual research project programme and its execution support several of these transferable skills.
11. Programme structures and features, curriculum units (modules), ECTS assignment and award requirements

Examinations
The modules available are listed below. Each student is free to choose the 8 or 9 modules on which to be examined, constrained only by at least 4 being ‘core’ modules (please see the tables below). Unless otherwise stated below, each subject is assessed by coursework and by an unseen written examination at the start of Term 3. The overall mark for the examinations is the average of the best 8 module marks that include at least 4 core modules.

Laboratory
This consists of experiments carried out during the autumn and spring terms.

Individual Research Project
This is executed part-time from January to March and full-time from after the last exam (usually late May) to the week previous to the poster presentation.

Poster Presentation
Poster presentations will normally take place in mid-September.

ECTS
The Course awards 90 ECTS points which are separated into three course elements as follows:
- Each of the eight taught modules attracts 5 ECTS points for a total of 40 ECTS.
- Laboratory work attracts 10 ECTS points
- The dissertation attracts 40 ECTS points (34 ECTS awarded for the dissertation and 6 ECTS for a related seminar presentation)

Award of the MSc
A student will be awarded the highest grade of MSc for which the following conditions are satisfied:

MSc
1. at least 40% for each of the 8 modules counted for the computation of the examinations average
2. at least 50% for the laboratory average
3. at least 50% for both the project and examinations average

MSc with Merit
1. at least 40% for each of the 8 modules counted for the computation of the examinations average
2. at least 50% for the laboratory average
3. at least 60% for both the project and examinations average

MSc with Distinction
1. at least 40% for each of the 8 modules counted for the computation of the examinations average
2. at least 50% for the laboratory average
3. at least 70% for both the project and examinations average.

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Type</th>
<th>Course Title</th>
<th>Coursework Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE9-SC1 Core</td>
<td>Digital Signal Processing and Digital Filters</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SC2 Core</td>
<td>Advanced Communication Theory</td>
<td>15% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SC3 Core</td>
<td>Probability and Stochastic Processes</td>
<td>15% coursework</td>
<td></td>
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<tr>
<td>EE9S.LAB Core</td>
<td>S1 LAB</td>
<td>100% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO9 Core</td>
<td>Optical Communications</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO11 Core</td>
<td>Coding Theory</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO14 Core</td>
<td>Digital Image Processing</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO28 Core</td>
<td>Topics in Large Dimensional Data Processing</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO24 Core</td>
<td>Machine Learning for Computer Vision</td>
<td>0% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO25 Core</td>
<td>Wireless Communications</td>
<td>30% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO26 Core</td>
<td>Network and Web Security</td>
<td>15% coursework</td>
<td></td>
</tr>
<tr>
<td>EE9-SO27 Core</td>
<td>Distributed Computation &amp; Networks: a performance perspective</td>
<td>100% coursework</td>
<td></td>
</tr>
</tbody>
</table>
Choose and begin work on the Individual Research Project; normally the project is chosen from those offered by staff however a student may undertake a suitable self-proposed project or a suitable project at another research institution. Suitability is determined by the course director.

Unseen written examinations in April-May followed by work on the Individual Research Project until the end of September.

The individual, full-time research project begins at the end of Term 2. Project work is interrupted for the Examinations, and recommences one week after the final examination (usually from the beginning of June until the middle of September). The projects are conducted at Imperial College's South Kensington Campus site or at the premises of a commercial Company when a project is industry based. The titles of the research projects, offered by prospective supervisors are made available in Term 1. On completion of the project a written report is produced and submitted for assessment late in September. A mini, conference style poster session follows the dissertation submission and gives candidates the opportunity to present the results of their research to their colleagues, their instructors and other Department Staff.

Examination results are reviewed and Degrees are awarded at the annual Examiners meeting, usually held 1 month after the end of the Course.

12. Support for students and their learning

General:
- An induction programme during the first week for orientation, introduction to library, computer facilities and the Department;
- MSc Student Handbook, which includes lecture timetable and information;
- A large community of postgraduate research students and postdoctoral research associates who work on communications and/or signal processing research in the South Kensington Campus;
- A comprehensive external speaker seminar programme at the South Kensington Campus;
- Library and other learning resources and facilities at the South Kensington Campus;
- Dedicated computing facilities including a MSc study room including dedicated computers, wireless access and hot-desking, as well as a nearby 'social' area;
- Access to Teaching and Learning Support Services for assistance and guidance and to the Imperial College Careers Advisory Service;
- Students conducting their research projects at an external site are assigned a member of Imperial College academic staff to oversee progress and advise on the project dissertation. Where practical, students will be visited by College staff during their project;
- Opportunities for students to conduct their research projects at a wide range of internal laboratories at Imperial College, and possibly at external research institutions and companies;

Pastoral:
- Student email and open personal access to tutorial staff including the course director;
- Departmental Postgraduate Tutor who has overall responsibility for student welfare and guidance;
- The thesis supervisor doubles as a personal tutor; The supervisor assists students with personal problems and advises on pastoral and academic issues;
- Access to student counsellors and college tutor on the South Kensington Campus;
- Access to Teaching and Learning Support Services, which provide assistance and guidance, e.g. on careers.
- In addition to the Course administrator and tutor, who has overall responsibility for student welfare and guidance, all students are allocated personal tutors whose role is to assist them with personal problems and to advise on pastoral and academic issues;

Social:
- A large community of postgraduate research students and postdoctoral research associates who work on Communications and Signal processing research in the South Kensington Campus;
- Access to student Clubs offering diverse recreational activities on the South Kensington Campus.

Administrative:
- A Postgraduate staff - student committee, which meets three times per year.
- A Student Representative who regularly provides feedback to the course director.

Career Advice:
- Employer needs and opinions feed into the programme through frequent guest lecturers from industry and possible student placements in relevant industries and industry-based research projects;
- Course content incorporates industrial feedback through the twice annually Strategic Advisory Group meeting of research group heads and deputy heads with UK industry leaders.
13. Criteria for admission
Our academic entry requirement is a 1st Class Honours degree in Electrical Engineering, Physics or Mathematics from a UK academic institution. If studying at a Chinese university we would be looking for an overall degree total above 85%. If you are studying on a 2+2 programme we would be looking for a 1st Class degree with a final year mark above 75%. Offers made to students are initiated by the Postgraduate Admissions Tutor. When an applicant has a lesser degree qualification but has at least 3 years of work experience, exceptionally the Postgraduate Admissions Tutor will make a special case for admission; few such applications are made.

14. Methods for evaluating and improving the quality and standards of teaching and learning
Mechanisms for review and evaluation of teaching, learning, assessment, the curriculum and outcome standards
The external examiner system and Boards of Examiners are central to the process by which the College monitors the reliability and validity of its assessment procedures and academic standards. Boards of Examiners comment on the assessment procedures within the College and may suggest improvements for action by relevant departmental teaching Committees.

The Faculty Studies Committees and the Graduate Schools’ Postgraduate Quality Committees review and consider the reports of external examiners and accrediting bodies and conduct periodic (normally quinquennial) and internal reviews of teaching provision. Regular reviews ensure that there is opportunity to highlight examples of good practice and ensure that recommendations for improvement can be made.

At programme level, the Head of Department/Division has overall responsibility for academic standards and the quality of the educational experience delivered within the department or division.

Most of the College’s undergraduate programmes are accredited by professional engineering and science bodies or by the General Medical Council. Accreditation provides the College with additional assurance that its programmes are of an appropriate standard and relevant to the requirement of industry and the professions. Some postgraduate taught courses are also accredited.

Committees with responsibility for monitoring and evaluating quality and standards:
The Senate oversees the quality assurance and regulation of degrees offered by the College. It is charged with promoting the academic work of the College, both in teaching and research, and with regulating and supervising the education and discipline of the students of the College. It has responsibility for approval of changes to the Academic Regulations, major changes to degree programmes and approval of new programmes.

The Quality Assurance Advisory Committee (QAAC) is the main forum for discussion of QA policy and the regulation of degree programmes at College level. QAAC develops and advises the Senate on the implementation of codes of practice and procedures relating to quality assurance and audit of quality and arrangements necessary to ensure compliance with national and international standards. QAAC also considers amendments to the Academic Regulations before making recommendations for change to the Senate. It also maintains an overview of the statistics on completion rates, withdrawals, examination irregularities (including cases of plagiarism), student appeals and disciplinaries.

The Faculty Studies Committees and Graduate School Postgraduate Quality Committees are the major vehicle for the quality assurance of undergraduate / postgraduate courses respectively. Their remit includes: setting the standards and framework, and overseeing the processes of quality assurance, for the areas within their remit; monitoring the provision and quality of e-learning; undertaking reviews of new and existing courses; noting minor changes in existing programme curricula approved by Departments; approving new modules, changes in module titles, major changes in examination structure and programme specifications for existing programmes; and reviewing proposals for new programmes, and the discontinuation of existing programmes, and making recommendations to Senate as appropriate.

The Faculty Teaching Committees maintain and develop teaching strategies and promote inter-departmental and inter-faculty teaching activities to enhance the efficiency of teaching within Faculties. They also identify and disseminate examples of good practice in teaching.

Departmental Teaching Committee has responsibility for the approval of minor changes to course curricula and examination structures and approve arrangements for course work. It also considers the details of entrance requirements and determine departmental postgraduate student numbers. The Faculty Studies Committees and the Graduate School Postgraduate Quality Committees receive regular reports from the Departmental Teaching Committees.

The departmental Student Staff Committee convenes once every term and provides a forum for students to raise concerns or provide feedback. The committee is chaired by the Director of Postgraduate studies and membership comprises the Postgraduate Tutor, Postgraduate administrator, Course Directors and student representatives one from each of the five Research Groups and one from each of the four taught MSc Courses.

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;
Mechanisms for gaining student feedback on the quality of teaching and their learning experience:
- Elected student representative has unrestricted access to course director, and participates in student-staff committee meetings held termly
- College Online lecturer’s evaluation programme (MOLE)

Mechanisms for monitoring the effectiveness of the personal tutoring system:
- Student feedback
- Availability of course director to discuss more difficult issues

Mechanisms for recognising and rewarding excellence in teaching and in pastoral care:
Staff is encouraged to reflect on their teaching, in order to introduce enhancements and develop innovative teaching methods. Each year College awards are presented to academic staff for outstanding contributions to teaching, pastoral care or research supervision. A special award for Teaching Innovation, available each year, is presented to a member of staff who has demonstrated an original and innovative approach to teaching. Nominations for these awards come from across the College and students are invited both to nominate staff and to sit on the deciding panels.

Staff development priorities for this programme include:
- Active research programme in Communications and Signal Processing topics;
- Staff appraisal scheme and institutional staff development courses;
- College Teaching Development Grant Scheme to fund the development of new teaching and appraisal methods;
- Updating professional and IT/computing developments.

15. Regulation of Assessment

a) Assessment Rules and Degree Classification:
The Pass mark for postgraduate taught courses is 50% on each element of the course. In order to be awarded a result of merit, a candidate must obtain an aggregate mark of 60% or greater; a result of distinction requires an aggregate mark of 70% or greater.

Where appropriate, a Board of Examiners may award a result of merit where a candidate has achieved an aggregate mark of 60% or greater across the programme as a whole AND has obtained a mark of 60% or greater in each element with the exception of one element AND has obtained a mark of 50% or greater in this latter element.

Where appropriate, a Board of Examiners may award a result of distinction where a candidate has achieved an aggregate mark of 70% or greater across the programme as a whole AND has obtained a mark of 70% or greater in each element with the exception of one element AND has obtained a mark of 60% or greater in this latter element.

b) Marking Schemes for undergraduate and postgraduate taught programmes:
The Pass Mark for all postgraduate taught course modules is 50%. Students must pass all elements in order to be awarded a degree.

c) Processes for dealing with mitigating circumstances:
A candidate for a Master’s degree who is prevented owing to illness or the death of a near relative or other cause judged sufficient by the Graduate Schools from completing at the normal time the examination or Part of the examination for which he/she has entered may, at the discretion of the Examiners,

(a) Enter the examination in those elements in which he/she was not able to be examined on the next occasion when the examination is held in order to complete the examination,
or
(b) be set a special examination in those elements of the examination missed as soon as possible and/or be permitted to submit any work prescribed (e.g. report) at a date specified by the Board of Examiners concerned. The special examination shall be in the same format as specified in the course regulations for the element(s) missed.

Applications, which must be accompanied by a medical certificate or other statement of the grounds on which the application is made, shall be submitted to the Academic Registrar who will submit them to the Board of Examiners.

d) Processes for determining degree classification for borderline candidates:
Candidates should only be considered for promotion to pass, merit or distinction if their aggregate mark is within 2.5% of the relevant borderline. Nevertheless, candidates whom the Board deems to have exceptional circumstances may be considered for promotion even if their aggregate mark is more than 2.5% from the borderline.

e) Role of external examiners:
The primary duty of external examiners is to ensure that the degrees awarded by the College are consistent with that of the national university system. External examiners are also responsible for approval of draft question papers, assessment of examination scripts, projects and coursework (where appropriate) and in some cases will attend viva voce and clinical examinations. Although external examiners do not have power of veto their views carry considerable weight and will be treated accordingly. External examiners are required to attend each meeting of the Board of Examiners where recommendations on the results of individual examinations are considered.
External examiners are required to write an annual report to the Rector of Imperial College which may include observations on teaching, course structure and course content as well as the examination process as a whole. The College provides feedback to external examiners in response to recommendations made within their reports.

### 16. Indicators of quality and standards
- IET accreditation report, 2013;
- Favourable comments on the MSc Course by External Examiners 2014;
- Research training, grant and publications record in Communications and Signal Processing and related areas;
- Internal QAA procedure within the Graduate School, 2011
- Independent review of the quality of the educational provision of the Electrical and Electronic Engineering Department by the Quality Assurance Agency subject review process (in 1997 the Department was awarded 24/24).

### 17. Key sources of information about the programme can be found in (links to course handbook, prospectus, departmental website, syllabus etc):
- Postgraduate Prospectus, Imperial College London ([https://www.imperial.ac.uk/study/pg/electrical-engineering/communications-signal-processing/](https://www.imperial.ac.uk/study/pg/electrical-engineering/communications-signal-processing/));
- Electrical Engineering Departmental Postgraduate Courses web page ([http://www3.imperial.ac.uk/electricalengineering/teaching/msc](http://www3.imperial.ac.uk/electricalengineering/teaching/msc));
- Course information handbook ([http://www3.imperial.ac.uk/electricalengineering/teaching/msc/comms](http://www3.imperial.ac.uk/electricalengineering/teaching/msc/comms));
- Imperial College application related information for postgraduate students ([https://apply.embark.com/grad/imperial/grad/46/default.asp](https://apply.embark.com/grad/imperial/grad/46/default.asp));
- QAA Subject Review Report Imperial College of Science, Technology & Medicine ([http://www.qaa.ac.uk/reviews-and-reports/provider?UKPRN=10003270#.VbZN-Pkt1dA](http://www.qaa.ac.uk/reviews-and-reports/provider?UKPRN=10003270#.VbZN-Pkt1dA)).