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. Some more detailed information on the content of each module can be found in the Postgraduate Prospectus (www.ic.ac.uk/p4513.htm). This Programme Specification will be available on www2.ee.ic.ac.uk/cap/education/index.htm by 4 October 2004. The Control Systems MSc Course Handbook will be distributed to the MSc students when they arrive and will be available on-line to staff and relevant students during 2004. The accuracy of the information contained in this document is reviewed by the University and may be checked by the Quality Assurance Agency.

1. Awarding Institution / Body	University of London
2. Teaching Institution	Imperial College London
3. External Accreditation by:	Not applicable
4. Final Award	MSc and DIC
5. Programme Title	Control Systems
6. UCAS Code (or other coding system if relevant)	Not applicable
7. Relevant QAA Subject Benchmarking Group(s)	Engineering
8. Date of production/revision	September 2004 for 2004-05

9. Educational Aims of the Programme

The programme is intended to:

- provide the theoretical basis for classical and modern control theory with associated design methods and algorithms
- produce graduates equipped to pursue careers that might involve classical and modern control concepts, theories, methods and controller design packages in industry, finance and the public sector;
- enable graduates to recognise and tackle problems to which control can be applied;
- offer students from a variety of mathematics-based disciplines, or who have been at work for some time, the opportunity to learn and/or refresh and/or deepen their knowledge and understanding of control;
- provide a good background that will
    - enable graduates to update their knowledge after they leave by reading the professional literature
    - assist graduates wishing to undertake research in or involving control.

10. Programme Outcomes - *the programme provides opportunities for postgraduate students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas. The programme outcomes are referenced (**B**) to the Benchmark Statement for Engineering.*

Knowledge and understanding

A. Knowledge and understanding of:	**Teaching/learning methods and strategies**
1. fundamental concepts and principles underpinning control system theory and design, including those associated with deterministic systems fuzzy systems stochastic systems modelling optimisation control system design on-line control;	Acquisition of A1 and A2 is through a combination of lectures, seminars, laboratory work, computer-based work, coursework. and guided reading. A4 is supported by various aspects of the individual research project, the coursework for the course Advanced Process Control and by attendance at a number of (GSEPS) skills workshops. The students are encouraged throughout to undertake independent reading both to supplement and consolidate material relevant to the lectures and project and to broaden their individual knowledge and understanding of the control area. Assessment of the knowledge base is through a combination of unseen written examinations and assessed coursework (A1) as well as the individual research project (A2 - A4).
2. the essential facts, concepts, principles and theories relevant to the student's chosen area of research for the individual project (**B**);	
3. information retrieval as a research technique;	
4. management and communication skills, including problem definition, project design, decision processes, teamwork, written and oral reports, scientific publications (**B**).	

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Skills and other attributes

B Intellectual (thinking) skills - able to:

1. (Analysis) model systems mathematically and apply relevant theory to study their properties and performance;
2. (Synthesis) apply control concepts and theory to the solution of control problems;
3. (Computing) apply computational principles and techniques to control problems;
4. (Evaluative) plan, conduct and report on a programme of original research.

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Teaching/learning methods and strategies

Intellectual skills are developed through the teaching and learning methods outlined above and in section 11

Assessment is through coursework, unseen written examinations and project work.

C Practical skills – able to:

1. formulate mathematical models of systems and identify the parameters of such models from observations using appropriate statistical techniques;
2. solve control analysis and synthesis problems using appropriate statistical, frequency-response and state-space methods;
3. analyse and interpret computed results;
4. write programs using at least one common language (Matlab);
5. understand the literature so personal knowledge and skills can be kept up-to-date;
6. define problems and design /manage associated projects;
7. write effective technical reports.

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Teaching/learning methods and strategies

Practical skills are developed through the teaching and learning programme outlined above (and in section 11).

Practical computational skills regarding C1-4 are developed through coursework and project work and through interaction with research supervisor(s) and (sometimes) research students. .

Skills C6-7 are taught and developed through guided reading and (GSEPS) workshops and practice, with feedback, associated with the individual project.

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, web-pages and written reports (**B**);
2. apply knowledge skills to new control problems;
3. (management skills) formulate problem definitions; design and evaluate projects using objective criteria (**B**);
4. integrate and evaluate information from a variety of sources (**B**);
5. transfer techniques and solutions from one discipline to another;
6. use Information and Communications Technology (**B**);
7. manage resources and time (**B**);
8. learn independently with open-mindedness and critical enquiry (**B**);
9. learn effectively for the purpose of continuing professional development (**B**).

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Teaching/learning methods and strategies

Transferable skills are developed through the teaching and learning programme outlined above and in section 11.

Skill D1 is taught through (GSEPS) workshops and feedback on individual project work.
Skills D2-6 are taught mainly through the individual research project.
Skill D7 is developed throughout the course within a framework of staged coursework deadlines and the examination system.
Although not explicitly taught, skills D8 and D9 are encouraged and developed throughout the course, which is structured and delivered in such a way as to promote this.

Skill D1 is assessed through written examinations, course work and the individual project.
Skills D2-D7 are assessed through coursework, written examinations and project work.
Skills D8-9 are assessed through project work.

11. Programme structures and features, curriculum units (modules), credit and award requirements

The students are examined on at least 7 of the examinable subjects listed below; all the subjects are examinable except for C1.5. Each student is free to choose the number (7 or more) of subjects on which to be examined and the subjects themselves. Unless otherwise stated below, each subject is assessed by coursework and by an unseen written examination at the start of Term 3. For subjects with written examination and coursework, the subject mark is determined as 0.75 * exam mark (%) + 0.25 * coursework mark (%). The overall mark for the examinations is computed as the average of the marks for the best 7 individual subjects. To pass the examinations, none of the best 7 marks must be below 50% and the average of the best 7 marks must exceed 55.7%. To be awarded the MSc, a student must pass the examinations and be awarded at least 50% for the project. For a distinction, both the overall examination mark and the project mark must be at least 70%.

Term 1	C1.1	Optimisation
	C1.2	Linear optimal control
	C1.3	Discrete-time systems and computer control
	C1.6	Mathematics for signals and systems
	C2.4	Fuzzy systems (examined by coursework and orally)
	C3.1	Advanced process control (examined by coursework alone)
	C3.2	Modelling and control in power engineering (no coursework)
Term 2	C1.4	Stability and control of non-linear systems
	C1.5	Topics on control systems (not examined)
	C2.1	Probability and stochastic processes
	C2.3	System identification
	C4.1	Design of linear multivariable systems
Term 3	Unseen written examinations in April-May followed by work on Individual Project until late September.	

The following reference point was used in creating the Programme Specification:

- Control Systems MSc Course Handbook
- Taught MSc Regulations

12. Support for students and their learning:

- An induction programme during the first week for orientation, introduction to library and information technology, and the Department;
- MSc Course Handbook, which includes descriptions of each lecture course;
- Staff student ratio for teaching: 8 teaching staff and 9 potential project supervisors for a class size that has varied recently between 15 and 27;
- Immediate access by email to staff for academic help or pastoral care;
- Personal Tutors who act as an interface between the student and the Administration;
- The Postgraduate Tutor, Senior Tutor, Director of Postgraduate Studies and Postgraduate Administrator are available if Personal Tutors do not suffice;
- A large community of postgraduate research students and postdoctoral researchers who work in the Control area. The research programmes in the Department provide general as well as specific support for appropriate individual projects;
- Library and other learning resources and facilities;
- Dedicated computing facilities;
- Many visiting speakers;
- Access to student counsellors on the South Kensington site;
- Access to Teaching and Learning Support Services for assistance and guidance and to the Imperial College Careers Advisory Service.

13. Criteria for admission

The minimum qualification for admission is normally an Upper Second Class Honours degree in Engineering, Physics. or Mathematics from a UK academic institution or an equivalent overseas qualification. All UK applicants (and, where possible, overseas applicants) are invited to the College for a site tour; offers made to students are initiated by the Postgraduate Admissions Tutor. Where an applicant has a lesser degree qualification but has at least 3 years' work experience, exceptionally the Postgraduate Admissions Tutor will make a special case for admission; few such applications are made. Students taking the course on a part-time basis are normally expected to be in relevant industrial employment. Furthermore the employer's agreement that the student will be allowed sufficient time to attend lectures will be required.

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

- Module reviews, based on feedback questionnaires.
- Annual course review prepared by the Course Director and considered by the Course Committee and the Departmental Teaching Committee.
- Biennial review of the course by an Imperial College academic staff member from outside the Department with a report and grading to the Quality and Academic Review Committee.
- MSc Staff – Student Committee, which meets each term and reports to the Departmental Teaching Committee.
- Biennial staff appraisal.
- Peer teaching observations.
- External Examiner reports and Industrial Advisory Board reports.
- Employer needs and opinions feed into the programme through guest lecturers from industry, student placements in relevant industries, industry-based projects, past students, our Strategic Advisory Group as well as collaboration between academic staff and industry in research and consultancy. The aims of the Strategic Advisory Group are concerned with Departmental coupling to the long term requirements of industry, both for research and education, including the content of MSc courses, topics for projects and co-operative studentships. At present the Strategic Advisory Group contains members from at least 17 external organisations (either companies or government research establishments).
- Periodic review of Departmental teaching by an external panel with members drawn from another university, a research institute and industry.

Committees with responsibility for monitoring and evaluating quality and standards

- Postgraduate Staff – Student Committee.
- Undergraduate Course Committee regarding courses also taken by MEng. students.
- Board of Examiners – meets in November to consider awards.
- Quality and Academic Review Committee
- Senate

Mechanisms for gaining student feedback on the quality of teaching and their learning experience:

- Staff – Student Committee;
- Course questionnaire evaluating overall course;
- Course questionnaire evaluation of modules;
- Meetings between MSc Course Director and Postgraduate Tutor.

Staff development priorities include:

- active research programme in the control area;
- staff appraisal scheme and institutional staff development courses;
- College Teaching Development Grant Scheme to fund the development of new teaching and appraisal methods;
- updating personal skills to take account of professional and IT/computing developments.

15. Regulation of assessment

Assessment rules & degree classification

Summary of grades, marks and their interpretation for MSc degree classification

GRADE	MARKS	INTERPRETATION
A	70% - 100%	Marks represent a distinction (truly exceptional or excellent) performance
B/C	50% - 69%	Marks represent a good or adequate pass
D	40% - 49%	Marks represent barely acceptable performance at MSc level
E	0% - 39%	Marks represent a fail performance

The requirements for passing the Control Systems MSc course and for obtaining a Distinction are given at the start of Section 11.

Role of External Examiner

The external examiner for this course is from another university and is nominated by the MSc Academic Board and approved by the Graduate School of Engineering & Physical Sciences Management (or Executive) Committee. The external examiner normally serves for 3 years and

- approves examination papers;
- reviews coursework;
- sees all examination scripts and individual research project dissertations;
- attends the Board of Examiners;
- completes a report to the College;
- provides informal feedback regarding the nature and direction of the Course.

16. Indicators of quality and standards

- Favourable comments by External Examiners;
- Research training, grant and publications record in Control and related areas;
- Evaluation by GSEPS;
- 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).

Please note. This specification provides a concise summary of the main features of the programme and learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if she/he takes full advantage of the learning opportunities that are provided. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each module can be found in the Course Handbook which is available to appropriate groups. The accuracy of the information contained in this document is reviewed by the College and may be checked by the Quality Assurance Agency for Higher Education (QAA).
Key sources of information about this course can be found in:

- Postgraduate Prospectus, Imperial College London (available on-line at www.imperial.ac.uk/P1212.htm)
- the Control Systems MSc page on the Control and Power Group site (www2.ee.ic.ac.uk/cap/education/index.htm).

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