

# **Handbook**

**MSc in Mathematics  
of Cryptography and Communications**

**MSc in Mathematics for Applications**

**and Postgraduate Diplomas in these courses**

**at Royal Holloway  
University of London**

Programme Director: Dr. Christian Elsholtz

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# MSc in Mathematics

*This document is a guide to the MSc and Postgraduate Diploma (PgDip) in Mathematics of Cryptography and Communications and to the MSc and PgDip in Mathematics for Applications. Please also see the College's Postgraduate Regulations for further information about your programme of study and student support services. <http://www.rhul.ac.uk/graduate-school/pages/current.html#regulations>*

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## 1 Introduction

This booklet describes the MSc and PgDip in Mathematics of Cryptography and Communications, and the MSc and PgDip in Mathematics for Applications, taught by the Mathematics Department at Royal Holloway.

These programmes aim to provide students with a solid mathematical foundation and a knowledge and understanding of the subjects of cryptography and communications, and various applications of mathematics, respectively. Students who successfully complete the programme will be prepared for research or professional employment in these areas.

The programmes are delivered over one year of full-time study or two years of part-time study. They provide in-depth training and research experience entirely at Masters level. Students receive training in generic, scientific and discipline-specific research skills.

The PgDip programme comprises taught courses, while the MSc programme comprises taught courses together with a major research project and the writing of a dissertation. For both programmes students are expected to demonstrate creativity in problem solving and the ability to critically analyse concepts and methods. Students are expected to be self-motivated and to exhibit a high degree of independence in their study.

The Mathematics Department at Royal Holloway is internationally regarded as a centre of excellence in research. The programmes complement the extremely successful MSc in Information Security which has been running for many years. The programmes are taught by members of the Mathematics Department and the Information Security Group. Therefore, students on the programmes have an opportunity to learn from experts. Students doing the MSc dissertation have the opportunity to perform independent research under the guidance of leading researchers. There is a large number of potential research supervisors covering a wide range of research topics.

The Department aims to comply with the College Regulations, Student Charter and Codes of Practice, The Codes of Practice cover Academic Welfare, Freedom of Speech, Student Union Affairs, Personal Harassment and Health and Safety. No interpretation of the information presented here should conflict with these regulations or codes of practice. In the case of any differences, the College Regulations will prevail.

## 2 Mathematics at Royal Holloway

The Mathematics Department is in the McCrea Building, at the centre of the campus and close to the spectacular Founder's Building. As well as staff offices, it includes some teaching rooms, a computer room and a common room specifically for MSc students. The Bedford Library is adjacent, and holds a good collection of books and other material in Mathematics.

In the Department of Mathematics there are about 40 members of the academic teaching staff. There are postdoctoral research fellows and assistants, and numerous PhD students, together with secretarial and technical staff. The research interests in the Department include information security, cryptography, coding theory, algebra, number theory, graph theory, mathematics of atomic processes, quantum theory, quantum information theory, statistics and operational research. Apart from its academic merits, Royal Holloway is well known for its friendly atmosphere. The academic staff are enthusiastic teachers and researchers, and the campus is great.

## 3 List of Staff Members

### 3.1 List of academic members of staff

A full list of members of staff is on the Departmental web page <http://www.ma.rhul.ac.uk/people/academic> Below is a list of members of staff that usually teach relevant courses.

When telephoning staff from outside College dial the Egham code (01784) if required and follow with:

44 if the extension number starts with 3

41 if the extension number starts with 4

27 if the extension number starts with 6

Proceed then the extension number. After 5 rings an unanswered call is diverted to the appropriate secretary.

Example: extension 3xyz gives 01784 443xyz.

Name	Responsibilities	Research Interests	Room num.	Phone	Email address
Dr. K. Audenaert		Quantum information theory	C345	6272	Koenraad.Audenaert@rhul.ac.uk
Prof. S. Blackburn	Academic Coordinator (UG)	Group theory, combinatorics, cryptography	C214	3422	S.Blackburn@rhul.ac.uk
Dr. Y. Barnea	Careers, Library	Algebra	C228	4689	Y.Barnea@rhul.ac.uk
Dr. J. Bolte		Quantum Physics	C352	6269	Jens.Bolte@rhul.ac.uk
Dr. C. Cid		cryptogr., security, computational algebra	C224	4685	carlos.cid@rhul.ac.uk
Dr. C. Davies		Magnetohydro-dynamics, astronomy	C231	nn	C.M.Davies@rhul.ac.uk
Dr. A. Dent		Public key encryption	C223	4922	A.Dent@rhul.ac.uk
Dr. R. Dietmann		Number theory	C239	3087	Rainer.Dietmann@rhul.ac.uk
Dr. C. Elsholtz	Programme director for MSc	Number theory, combinatorics	C240	4021	Christian.Elsholtz@rhul.ac.uk
Dr. C. Farmer		Quantum mechanics	C238	3083	C.Farmer@rhul.ac.uk
Dr. S. Gerke		Graph Theory, Combinatorics	C244	6225	Stefanie.Gerke@rhul.ac.uk
Prof. G. Harman	Undergraduate Admissions	Number theory	C245	4235	G.Harman@rhul.ac.uk
Mr. E. Godolphin		Statistics	FE145	3435	E.Godolphin@rhul.ac.uk
Dr. J. McKee	(on leave 2009/10)	Number theory, cryptography	C242	3670	James.McKee@rhul.ac.uk
Dr. B. Klopsch		Algebra	C220	4686	Benjamin.Klopsch@rhul.ac.uk
Dr. A. Koloydenko		Statistics	C209	6421	Alexey.Koloydenko@rhul.ac.uk
Dr. F. Mota-Furtado	Special needs, Erasmus, Socrates	Mathematical physics	C241	3096	F.Motafurtado@rhul.ac.uk
Prof. S. Murphy		Cryptography	C354	3699	S.Murphy@rhul.ac.uk
Dr. S.-L. Ng		Cryptography	C250	4397	S.Ng@rhul.ac.uk
Prof. P. O'Mahony	UG exams officer	Mathematical physics	C351	3088	P.OMahony@rhul.ac.uk
Dr. T. Osborne	(on leave 2009/10)	Quantum computation	C235	4983	Tobias.Osborne@rhul.ac.uk
Prof. R. Schack	Head of Department	Quantum computation, information theory	C234	3097	R.Schack@rhul.ac.uk
Dr. E. Scourfield		Number theory	C356A	3671	E.Scourfield@rhul.ac.uk
Dr. T. Sharia		Statistics and probability	C236	4331	T.Sharia@rhul.ac.uk
Dr. A. Sheer		Operational research	C231	nn	A.Sheer@rhul.ac.uk
Dr. D. Yates		Number theory	C356A	3078	D.Yates@rhul.ac.uk

## 3.2 List of secretarial and technical support staff

- Mrs Ling-Yu Chiu, Assistant Administrator, room C243, ext. 3093, ling-yu.chiu@rhul.ac.uk
- Liz Jenkins: Computer support, room C357, ext. 3116, E.Jenkins@rhul.ac.uk
- Jenny Lee: Secretary, room C243, ext. 3091, Jenny.Lee@rhul.ac.uk
- Lisa Nixon: Computer support, room C243, ext. 3106, Lisa.Nixon@rhul.ac.uk
- Guillaume Subra: Administrator Mathematics, room C232, ext. 3085, guillaume.subra@rhul.ac.uk

# 4 General Programme Information

## 4.1 Programme Aims

The aims of the MSc in Mathematics of Cryptography and Communications are:

- To provide a suitable mathematical foundation for undertaking research or professional employment in cryptography and/or communications.
- To provide students with the appropriate background in information theory and coding theory to enable them to understand and be able to apply the theory of communication through noisy channels.
- To provide students with the appropriate background in algebra and number theory to develop an understanding of modern public key cryptosystems.
- To provide students with a critical awareness of problems in information transmission and data compression, and the mathematical techniques which are commonly used to solve these problems.
- To provide students with a critical awareness of problems in cryptography and the mathematical techniques which are commonly used to provide solutions to these problems.
- To give students the opportunity to carry out an independent research investigation into the mathematics of cryptography and/or communications.
- To provide students with a range of transferable skills appropriate to progression to PhD Studies or employment, including familiarity with a computer algebra package, experience with independent research and managing the writing of a dissertation.

The aims of the Postgraduate Diploma (PgDip) in Mathematics of Cryptography and Communications are as above, with the exception of those aspects relating to the research investigation and the writing of a dissertation.

The aims of the MSc in Mathematics for Applications are related. But please note that you have some more choice in your courses. Whether you want to study mathematics in applications to physics, for example, is your choice.

The aims stated in the programme specification are:

- to provide teaching in mathematics, beyond the level of a first degree, in selected areas of mathematics and their applications;
- provide a suitable mathematical foundation for undertaking research or professional employment;
- provide students with the appropriate background in algebra, cryptography and coding theory to enable them to understand and be able to apply discrete mathematics to problems in communications;
- provide students with a critical awareness of selected problems in the real world, and the mathematical techniques which are commonly used to solve them;

- give students the opportunity to carry out an independent research investigation in a selected area of mathematics and its applications;
- provide students with a range of transferable skills appropriate to progression to PhD studies or employment, including experience with independent research and managing the writing of a dissertation.

The aims of the Postgraduate Diploma (PgDip) in Mathematics for Applications are as above, with the exception of those aspects relating to the research investigation and the writing of a dissertation.

## 4.2 Learning Outcomes

The programme complies fully with Descriptors for Masters level qualifications set out by the Quality Assurance Agency for Higher Education in England and Wales (QAA) as all of its learning outcomes are at Masters (M) level. In general terms, the MSc and Postgraduate Diploma programme provides opportunities for students to develop and demonstrate the following learning outcomes:

### 4.2.1 Mathematics of Cryptography and Communication

Knowledge and understanding of

- The principles of information transmission, data compression and information theory.
- The principles of communication through noisy channels using coding theory.
- The principles of cryptography as a tool for securing data.
- The algebra and number theory behind public key cryptography.
- The mathematics behind symmetric key cipher systems.
- The principles of cryptanalysis and experience with some of the algorithms used to break cryptosystems.
- The role and limitations of mathematical ideas in information security.

Skills and other attributes

- Demonstrate a high level of ability in subject specific skills, including algebra and number theory.
- Ability to clearly formulate problems and express technical content and conclusions in written form.\*
- Time management.\*
- Self-motivation, flexibility and adaptability.\*
- Computer skills.\*
- The ability to critically analyse the strengths and weaknesses of solutions to problems in cryptography and communications.

Skills and other attributes (MSc only)

- Synthesise information from a number of sources with critical awareness.\*
- Evaluate research critically.\*
- Preparation of an MSc dissertation.\*

\* transferable skills

### 4.2.2 Mathematics for Application

Knowledge and understanding of:

- the principles of communication through noisy channels using coding theory;
- the principles of cryptography as a tool for securing data;
- the role and limitations of mathematics in the solution of problems arising in the real world.

Skills and other attributes:

- demonstrate a high level of ability in subject-specific skills, such as algebra and number theory;
- ability to clearly formulate problems and express technical content and conclusions in written form;\*
- time management;\*
- self-motivation, flexibility and adaptability;\*
- computer skills;\*
- the ability to critically analyse the strengths and weaknesses of solutions to problems in applications of mathematics.

Skills and other attributes (MSc only):

- synthesise information from a number of sources with critical awareness;\*
- evaluate research critically;\*
- preparation of an MSc dissertation.\*

\* transferable skills

## 4.3 Entry Requirements

Students are eligible to apply if they have a first class or upper second class BSc with Mathematics as a main field of study from a university in the UK. Equivalent overseas qualifications are accepted. The full list of acceptable qualifications for entry to Masters degrees can be found in the University regulations. Exceptionally, at the discretion of the programme director, qualifications in other subjects (for example, physics or computer science) or degrees of lower classification than upper second class may be accepted. Both full-time and part-time programmes are offered.

Those overseas students whose first language is not English and those without a degree from a UK university should achieve an overall score of 6.5 in IELTS and a score of 7.0 in the writing component; alternatively, they should possess a computer-based TOEFL score of 250 with an essay rating of 6.0 or a paper-based TOEFL of 600 with 6.0 in TWE (Test of Written English). Students with at least an IELTS score of 6.5 overall and 6.0 for the writing component, or a TOEFL 580/TOEFL CBT 237 with a TWE/Essay 5.0 qualify for admission to the Colleges 4-week pre-session programme. Students with at least IELTS 6.0 overall and 6.0 for writing, or TOEFL 570/TOEFL CBT 230 with TWE/Essay 4.5 can qualify for the 8-week pre-session programme.

## 4.4 Programme Structure and Content

**Autumn term (Term 1):** Monday 21 September to Friday 11 December 2009 (lectures start Monday 28 September).

**Spring term (Term 2):** Monday 11 January to Friday 26 March 2010 (11 weeks)

**Summer term (most exams are in the first 4-5 weeks):** Monday 26 April to Friday 11 June 2010 (7 weeks)

**Deadline of MSc Thesis:** Thursday 2nd September 2010, (exact hour to be confirmed).

**Graduation ceremonies:** probably mid July 2011, will be confined on the web site:

<http://www.rhul.ac.uk/College-Profile/calendar.html#terms>

The *full time* MSc lasts for 50 weeks, from late September until beginning of September in the following year. You are expected not to take on any job that would prevent you spending most of your time on the MSc course.

The MSc is examined in two parts; by written examination (mainly in May), and by a dissertation on a project to be submitted in September. This is called the main project to distinguish it from any projects that form part of a course unit.

Students initially choose 8 courses of which they later specify 6 courses (including the core courses below) that will count towards the examination. These 6 courses count as a half unit each. The main project counts as a full unit, so that each student will be examined on  $6 \times 0.5 + 1 = 4$  units.

Students typically write 6, 7 or 8 exams (the 6 specified count, the others are optional).

A *part time* MSc lasts for 102 weeks, from September to September two years later. The normal outline is:

Year 1: lectures and examinations on four half-units (typically the core courses). A student must pass 1.5 units in order to proceed to Year 2.

Year 2: four more half-units followed by the main project.

The lecture courses are separate courses; all of these are valued as half units. Normally each student takes four courses (2 units) in each of the first two terms. Two of the eight courses are 'electives'. Elective courses appear on students transcripts but do not contribute to the final degree classification. Students decide during the second term which courses are to be considered as elective.

The Examinations office will probably ask you to specify the exams that you will write very early. The reason why they do this is the involved exam time table. In the past, the programme director was able to negotiate a later deadline, watch out for info (by email) from the programme director.

## 4.5 List of Courses

### Core Courses on the MSc Mathematics for Applications

code	title	term	lecturer
MT5400	Main Project	summer	all lecturers/full unit
MT5462	Advanced Cipher Systems	1	Ng/Cid
MT5485*	Applications of Field Theory	1	Klopsch
MT5461	Theory of Error-Correcting Codes	2	Audenaert

\* We are currently changing regulations so that MT5485 would not be compulsory, see induction week for details.

### Core Courses on the MSc Mathematics of Cryptography and Communications

code	title	term	lecturer
MT5400	Main Project	summer	all lecturers/full unit
MT5441	Channels	1	Audenaert
MT5461	Theory of Error-Correcting Codes	2	Audenaert
MT5462	Advanced Cipher Systems	1	Ng/Cid
MT5466	Public Key Cryptography	2	Blackburn

## Courses

code	title	term	lecturer
MT5400	Main Project	summer	all lecturers/full unit
MT5412	Computational Number Theory	1	not in 2009/10
MT5413	Complexity Theory	2	Dent
MT5420	Advanced Quantum Theory	2	Farmer
MT5421	Aerodynamics and Geophysical Fluid Dynamics	2	not in 2009/10
MT5422	Advanced EM and Spectral Relativity	1	not in 2009/10
MT5423	Magnetohydrodynamics	2	Davies
MT5441	Channels	1	Audenaert
MT5445	Quantum Information Theory	2	O'Mahony
MT5447	Advanced Financial Mathematics	2	Sheer
MT5454	Combinatorics	1	Barnea
MT5461	Theory of Error Correcting Codes	2	Audenaert
MT5462	Advanced Cipher Systems	1	Ng/Cid
MT5465	Advanced Network Algorithms	1	Gerke
MT5466	Public Key Cryptography	2	Blackburn
MT5485	Applications of Field Theory	1	Klopsch
MT5486	Permutations and Counting with groups	1	not in 2009/10

Note that some courses consist of 3 lectures a week, and others consist of 4 lectures a week.

Courses with 4 lectures a week: MT5461, MT5462, MT5465. Ask the lecturer for details.

This booklet gives descriptions of all postgraduate (MT5xxx) courses. Note that many of these courses coincide with fourth year MSci courses, though for MSci students the course numbers are different but related: for example MT5485 (MSc) is the same as MT4850 (MSci).

The following final year undergraduate courses may be relevant. The syllabi are on the web site <http://www.ma.rhul.ac.uk/students/bluebook/thirdyearcourses>

code	title	term
MT3110	Number Theory	2
MT3200	Quantum Theory I	1
MT3220	Dynamics of Real Fluids	1
MT3230	Magnetohydrodynamics	2
MT3280	Non-linear Dynamical Systems	1
MT3310	Experimental Design	1
MT3320	Inference Theory	2
MT3340	Time Series Analysis	1
MT3360	Applied Probability	1
MT3470	Mathematics of Financial Markets	1
MT3510	Computation and Numerical Analysis	2
MT3690	Game Theory	2
MT3810	Algebra III	2

### 4.6 Courses to be taken

Each student must take the core courses listed above and chooses further courses so that each student attends lectures on 8 taught half units, and writes the main project.

At the discretion of the Programme Director, the requirement to take a core course may be dropped if a student has already taken an equivalent course at a comparable level as part of their previous studies (in which case the student will take an extra optional course).

A full list of other optional courses is also given above. Recommended optional courses for the MSc of Cryptography and Communications include Applications of Finite Fields (MT5485), Quantum Information Theory (MT5445), Network Algorithms (MT5465), Computational Number Theory (MT5412), Complexity Theory (MT5413) and Combinatorics (MT5454). Students on the MSc Math-

ematics for Applications might like to make use of the very wide range of courses, from areas in discrete mathematics to applications in physics or financial mathematics.

A student may also, with the agreement of the Programme Director, choose one course from the third and fourth year options of the undergraduate degree programme in Mathematics. Normally, such agreement will only be given to fill gaps in the mathematics covered by the students first degree. Note that undergraduate courses can only be taken as ‘electives’ and the marks obtained in such courses cannot be included in the calculation of the degree classification.

As well as the taught courses all MSc students (but not PgDip students) will prepare a main project, which is a major piece of independent study. This project work will be undertaken under the supervision of an appropriate member of staff. The assessment will be on the basis of a written report; the examiners may also at their discretion require an oral examination. The dissertation on the main project is usually of length between 8,000 and 16,000 words and must be submitted at the beginning of September of the calendar year of completion of the written part of the examination. (the precise deadline will be specified at the beginning of the academic year).

## 4.7 Organisation of the teaching and teaching methods

Each half-unit course runs throughout either Term 1 or Term 2, and students are encouraged to divide their courses equally between the terms.

Teaching for each course is organised as formal lectures and informal seminars or guided reading. Learning is augmented by occasional computer projects and independent private study using books, course notes and the internet. For the dissertation, learning is by independent research and private study, supported by research supervision. For each taught course the lecturer will usually provide regular homework exercises for students to work through in their own time, and the feedback obtained from these is a valuable part of the learning process.

## 4.8 Online resources, Moodle

Many lecturers use Moodle

<http://moodle.rhul.ac.uk/>

to post their weekly problem sheets or other information on the course.

Some departmental online resources are at

<http://www.ma.rhul.ac.uk/students/pass>

The library also has many online resources that may be of use for your course.

## 4.9 Assessment

Each of the courses listed is assessed by a two-hour written examination and marked on a scale of 0-100%, with the pass mark of 50%. Some courses may also require extended essays, reports or computer programming. Passing a course requires a sound understanding of the subject area as well as the ability to express theoretical mathematics and solutions to problems clearly in written form. Details of the assessment of the main project are given in section 9.1.2 below.

The weekly homework exercises are marked but these marks do not contribute to the final grade for the course. Students should hand in solutions (or partial solutions) to these exercises each week for the following reasons:

- It is a college regulation that all course work is completed and submitted for assessment. Failure to comply may lead to a formal warning and the award of incomplete or non-examined status on that course.
- Solving problems is an essential part of the learning process in mathematics. The homework exercises are designed to reinforce and progressively develop the ability to solve problems in mathematics. Some problems are harder than others, and students should not necessarily expect to necessarily solve every exercise on the sheet.

- If, due to illness or other good cause, students fail to attend an examination or their performance is affected, the record of their homework marks will be taken into account.

Students receive regular feedback on: their performance on coursework for taught courses; their dissertation plan and draft proposal (end of examinations term); their detailed research proposal (early summer); and dissertation drafts near the completion of the project. Completion of tasks is monitored centrally to ensure students experiencing difficulty can be identified and provided with appropriate support.

## 4.10 Award Classification

**The regulations about the degree classification are currently under review. You will be updated on this, if there are any changes. The regulations below are those that are valid up to now.**

In order to be awarded the MSc degree students must achieve the pass mark of 50% on the six non-elective courses (including all the core courses taken by the student), and achieve at least a pass grade in the main project. Students who complete the taught courses, but who do not complete a dissertation may be awarded a Postgraduate Diploma in Mathematics of Cryptography and Communications/Mathematics for Applications.

The assessment is based on the courses and dissertation listed above.

- 75% of the assessment is taken to be the average mark of six (non elective) taught courses (3 units). The six courses over which the marks are averaged must all be of Masters level and must include at least three core courses (MSc Maths for Applications: at least 2 core courses). For each individual course the pass mark is 50%.
- 25% of the assessment is on the written dissertation. The dissertation is marked by two internal examiners, one of whom is normally the project supervisor, and an external examiner moderates the assessment. Examiners have the right to conduct an oral examination if they wish to check the students' knowledge and understanding.

To pass the MSc programme a student must achieve an overall weighted average of at least 50.00%, with no mark in a weighted taught course or the dissertation falling below 50%. Failure marks between 40-49.99% in taught courses can be condoned in courses which do not constitute more than 25% of the final assessment, provided that the overall weighted average is at least 50.00%, but a failure mark (i.e. below 50%) in the dissertation cannot be condoned.

The requirements for the award of the MSc are:

**Distinction:** an overall weighted average of 70.00% or more, provided that the marks for the dissertation and all courses are at least 60%.

**Merit:** an overall weighted average above 65.00%, provided that the marks for the dissertation and all courses are at least 50%.

**Pass:** an overall weighted average above 50.00%, provided that the marks for six taught courses and the dissertation are all 50% or above.

**Fail:** an overall weighted average of 49.99% or less, or fewer than six courses passed or a dissertation mark of less than 50%.

**A failure mark of 40% or more in up to two half units may be condoned.**

Example: The course marks are 70, 60, 60, 50, 45, 42, the project mark is 55. The two courses below 50 are condoned. The average is  $\frac{(70+60+60+50+45+42)+2*55}{8} = 54.625$ , which gives a "Pass".

Students may resit or retake a failed individual course or resubmit their dissertation once only. Normally this would be 12 months after the initial failure. Marks for resat or retaken courses or dissertation will be capped at 60%. A distinction will not normally be awarded if any element has been sat, failed and resat or retaken.

**The Postgraduate Diploma** is available for Masters students as an early exit award if they fail or opt out of the dissertation, and only if all the requirements for obtaining the PG Diploma have been fully met.

For the Postgraduate Diploma, there is no dissertation mark, so 100% of the assessment is the average mark for six passed taught courses. The requirements for the Postgraduate Diploma are: **Distinction:** an overall weighted average of 70.00% or more, provided that a mark of at least 60% is obtained for all courses.

**Merit:** an overall weighted average above 65.00% provided that a mark of at least 50% is obtained for all courses.

**Pass:** an overall weighted average above 50.00%, provided that the marks for six taught courses are 50% or above.

**Fail:** an overall weighted average of 49.99% or less or fewer than five courses passed.

A failure mark of 40% or more in one course (i.e. half unit) may be condoned.

## 5 Academic Welfare of Students

### 5.1 Points of contact

The Department is very concerned with the academic welfare of students. Students are encouraged to make full use of the Department and College support facilities. In particular, the following points of contact or information are made available:

- Programme director: The programme director meets the students during the induction meeting at the beginning of the academic year (if not earlier during the application and admissions process). The programme director acts as a point of contact for any questions about the programme throughout the year.
- MSc dissertation supervisor: All MSc students are allocated a supervisor during term 2, with whom they meet regularly to discuss all matters relating to their dissertation.
- Personal adviser: All students are allocated a personal adviser, with whom they meet at least once a term, and more regularly if required, to discuss all matters relating to their programme and for pastoral support.
- Representation on the Postgraduate Student Committee.
- All academic staff are available and accessible through an open-door policy or by operating an office hours system.
- Programme handbook.
- Supporting materials and learning resources in the Department, College libraries and computer centre.
- Access to all College and University support services, including Student Counselling Service, Health Centre, Careers Office, and the Education Support Office (for students with special needs).
- Secretarial and technical support staff as detailed in section 3.2.

### 5.2 Induction

At the induction meeting in late September (which is typically when students are given this document), students are welcomed to the Department, given a copy of the timetable and the Postgraduate Departmental Handbook, and introduced to their personal adviser (see below). The choice of courses is then discussed. During the first week students also attend an introductory session on the Departments computing facilities, possibly Mathematica and Minitab, and an introduction to the Library.

The Postgraduate Departmental Handbook contains details of how the material. This booklet gives descriptions of all

### 5.3 Personal Advisers

Students will be allocated a personal adviser who is responsible for ensuring that their programme is both academically suitable and logistically possible. The adviser also provides a point of contact between students and the Department in case of problems arising at any time.

### 5.4 Email

The course director, your adviser or other lecturers will typically try to contact you by email, **so you must check your college email account regularly**. When you send an email to the Course director, adviser, lecturer, please include “MSc” in the subject line.

Also: clear junk mail regularly. If your mail box is full no new email can be received.

### 5.5 Common Room/Pigeonholes

Room C254 on the second floor of the McCrea building is a common room for all MSc students in the Mathematics department. This room contains a photocopier which can be used by all MSc students. There are also pigeonholes for any mail which has been addressed to you at the department.

### 5.6 Resolving Complaints

Complaints should initially be brought to course co-ordinators or the Programme Director, or alternatively to Directors of Graduate Study or Heads of Department. For the formal College complaints procedure, see <http://www.rhul.ac.uk/For-Students/complaints.html>.

### 5.7 Illness or Extenuating Circumstances

If, for any reason, you have an illness or other problem, which influences your ability to undertake your academic studies for any length of time, you should inform your Personal Tutor in the first instance.

- Any requests for extension of coursework and dissertation deadlines must normally be made in writing to the Programme Director at least 24 hours in advance of the deadline. Such extensions will only be granted in exceptional circumstances, on the grounds of illness or other personal hardship. You are usually required to submit medical evidence as appropriate.
- If the quality of your coursework and dissertation are likely to be significantly affected over a period of time by illness or other personal circumstances, you should inform the Chair of the Sub-Board of Examiners (normally the Programme Director) in writing so that these circumstances may be taken into account when deciding upon the award of final degrees. (Note that your Personal Tutor cannot pass on information to the Sub-board in respect of circumstances affecting assessment). Such cases must be supported by medical or other appropriate documentary evidence. For evidence to be taken into account in this way, it must be submitted no later than one week after the period of disruption to which it refers. Any information disclosed in this way will remain confidential.

Blank forms for completion by medical practitioners are available from the Registry. These forms should be used wherever possible, otherwise the statement should be written on the medical practitioners headed paper, and include the same information requested on the form.

### 5.8 Plagiarism

Plagiarism is the presentation of another person’s thoughts or words as though they were your own. This goes against everything for which a university stands for - that is, to encourage independent and original thinking about our subject and the world around us. According to the Royal Holloway, University of London Regulations Governing Examinations and Assessment Offences:

*'plagiarism' means the presentation of another persons work in any quantity without adequately identifying it and citing its source in a way which is consistent with good scholarly practice in the discipline and commensurate with the level of professional conduct expected from the student. The source which is plagiarised may take any form (including words, graphs and images, musical texts, data, source code, ideas or judgements) and may exist in any published or unpublished medium, including the internet.*

To commit plagiarism is therefore to defeat the purpose of taking a degree programme, at any level. The University and College, like all academic institutions, regard plagiarism as a serious examination offence, for which severe penalties may be imposed. Ultimately these penalties include withholding the award of the degree itself. The following guidelines, based on those of the Academic Registrar of the University of London, outline how plagiarism can be avoided:

*All work submitted, as part of the requirements for any examination of the University of London must be expressed in your own words and incorporate your own ideas and judgements. Plagiarism must be avoided, with particular care being necessary in coursework and essays and reports written in your own time. Direct quotations from the published or unpublished work of others must always be clearly identified as such by being placed inside quotation marks, and a full reference to their source must be provided in the proper form. Remember that a series of short quotations from several different sources, if not clearly identified as such, constitutes plagiarism just as much as does a single unacknowledged long quotation from a single source. Equally, if you summarise another person's ideas or judgements, you must refer to that person in your text, and include the work referred to in your bibliography. Failure to observe these rules may result in an allegation of cheating. You should therefore consult your Tutor if you are in any doubt about what is permissible.*

There are stringent penalties for cases of plagiarism. For a first offence, the Department would recommend the minimum penalty of zero for the coursework if the plagiarised material casts doubt on whether the student has satisfied the requirements to pass. This would clearly affect the average mark for the element. Where such a case is identified, all of the assessed work (including the Dissertation) would be examined for possible plagiarism. For further offences, the Head of Department has the discretion to recommend that a degree is not awarded at all.

The issue of plagiarism is not simply about dangers and penalties - the ability to express one's own ideas in one's own words, to synthesise and evaluate information from a range of sources, to acknowledge the work of others accurately and define ones own work in relation to it, and to co-operate productively in a group, are valuable skills both for the Masters course and for the world of work beyond. As part of the research training for the Masters programme, students will receive guidance on the writing of research. If you are in any doubt about the issue of plagiarism, please consult your personal tutor or the Programme Director (also refer to the postgraduate handbook). Further details about plagiarism and procedures for investigation can be found in the Royal Holloway, University of London Regulations Governing Examinations and Assessment Offences ([http://www.rhul.ac.uk/Registry/academic\\_regulations/](http://www.rhul.ac.uk/Registry/academic_regulations/))

While many students may not have English as their first language, this is no excuse for plagiarism. Students who continue to have difficulty with English should seek help from the Language Centre; 01784 443829, [language-centre@rhul.ac.uk](mailto:language-centre@rhul.ac.uk).

## 5.9 Late Submission of Work

The College policy on late submission of work is as follows:

- For work submitted up to 24 hours late, the mark will be reduced by ten percentage marks, subject to a minimum mark of a minimum pass.
- For work submitted more than 24 hours late, the maximum mark will be zero.

See also section 5.7.

To explain in more detail what the 10% percent rule means: This does not mean 10% of the mark awarded, rather that the mark is reduced by ten percentage marks. For example:

Example 1: Mark originally awarded 65% Mark after penalty applied for late submission (up to 24 hours late): 55

Example 2: Mark originally awarded 52% Mark after penalty applied for late submission (up to 24 hours late): 50 (minimum mark must be a pass mark)

Note that such a loss of can considerably spoil your overall average, so never ever submit your work late!

## 6 Guidelines for Writing up the Main Project/Dissertation

The main project (dissertation) accounts for 25% of the assessment for the MSc degree. You should expect to work conscientiously throughout the summer if you are to produce a satisfactory dissertation by the September deadline. You are reminded that the MSc course is full time education till mid of September (unless you have part time status) and that you are not supposed to take on any job that could prevent you from spending most of your time on the dissertation.

The first task, which should be completed by the middle of term 2, is to decide upon a general area of research (this can be rather vague, e.g., coding theory, symmetric cryptography, quantum computing etc) and a suitable project supervisor. Course lecturers will be able to give suggestions about the general area of research. Note that students are not guaranteed the supervisor of their choice, though we try to ensure that all students have a supervisor who is appropriate to their subject of interest. If you are unable to choose a supervisor or a research area then you should see the programme director during the first half of term 2. By the end of term 2 (last week of lectures) students should produce a brief research proposal, of about 10 pages. This should give an introduction to the general subject area and of the more specific problems and objectives to be studied. It should mention which literature has been studied so far and how the research will continue. This will usually be prepared in consultation with the project supervisor.

While this proposal does not count toward the final grade it is still a compulsory part of your dissertation. The research proposals are approved by the external examiner for the MSc programme at the Examinations Sub-Board meeting in June. Failure to complete a satisfactory proposal could result in the student being demoted from the MSc programme to the PgDip.

During the Easter vacation students might want to revise for their exams. But since they already know the topic of their project they can use some time reviewing the literature further. Students should focus attention on their research projects immediately after their exams are finished.

Students should use the library and online resources to consult books, journals, conference proceedings and web pages. An important aspect of the project is for students to locate and evaluate different information from different sources. Supervisors are able to provide suggestions of where to look, and how to go about assessing the merits of information, but it is the students responsibility to ensure that the literature search is thorough and that all resources are analysed critically. Students typically meet their supervisor for approximately 8-10 supervision sessions.

Students should aspire to perform some independent investigation (rather than just reading existing documents) as part of their project. This may involve mathematical research to find and prove new results, computer implementation or experimentation, inventing new techniques for problem solving, applying existing techniques to solve new problems, or giving a thorough comparison of different solutions to problems from the existing literature.

The final part of the project is to prepare the dissertation. It is important to allow plenty of time for this stage (typically at least one month). Usually your supervisor will be ready to read one draft version, (but will not usually read the same chapter several times).

The dissertation should include:

- An introduction which outlines and motivates the topic of the thesis and shows how the topic fits into the wider area of cryptography and/or communications.
- A discussion of the existing literature on the subject.
- A presentation of the original content of the project, with a full explanation of the methods used and outcomes obtained.
- A conclusions section which shows how the results relate to the wider subject area and which suggests some possible future lines of enquiry.
- A list of references.

For further important info see the description of course MT5400 below.

For a much more thorough discussion of issues related to project research and dissertation writing, please see the Project Guide for the MSc in Information Security, available from:

<http://www.isg.rhul.ac.uk/msc/modules/IY5500>

### **Referencing**

It is essential that referencing of existing literature is done accurately and comprehensively. This is both good academic practice as well as being a safeguard against allegations of plagiarism. Guidelines on referencing and examples of good practice will be provided by the Programme Director at the beginning of the summer. Useful information about referencing can be found in the Project Guide for the MSc in Information Security, available from:

<http://www.isg.rhul.ac.uk/msc/teaching/isproject/ProjectGuideCampus05.zip>

## **7 Support and Facilities for Students**

### **7.1 The Health Centre**

The Health Centre is available for all students. It is located in the Founders building, on the first floor of the East wing. The telephone number for appointments or medical advice is (01784) 443131.

### **7.2 The Educational Support Office**

The Educational Support Office (located in the Founders building FW151) provides support for students with special needs. Any student who requires such support should register with the educational support office (this includes students who wish to have extra time in examinations).

### **7.3 The Graduate School**

The College's Graduate School supports the academic community, particularly postgraduate students, and coordinates their training and skills programmes. Details are in the booklet Introduction to Postgraduate Study. The Postgraduate Association, together with the Student Union, fosters social activities of all sorts, from interdisciplinary seminars to parties.

### **7.4 Computer Services and Software**

#### **7.4.1 Access, rooms**

As well as the PCs available in C103 (shared with the Computer Science Department) and C356, you have access to PCs in the Computer Centre and elsewhere on campus. For access to the PC's in the MSc room C254 you need to sign an extra form, please see Lisa Nixon. Details of all the Department computer facilities are available on the Department website: <http://www.ma.rhul.ac.uk/students/it>

### **7.4.2 Printing**

You will be given a department printing allowance each teaching term, which may be used to print on Departmental and Computer Centre printers. Once the Departmental allowance has been used additional print credit may be purchased from the computer centre service desk or credit machines around campus. Please note that Department credit is used in preference to any personal credit a user may have. Further details about the Department printing allowance are available from the website above.

### **7.4.3 IT Support**

Departmental support for any hardware or software issues can be obtained from the Department IT helpdesk at <https://helpdesk.ma.rhul.ac.uk> .

## **7.5 Mathematica**

Mathematica is available on most PCs on campus including those in C103 and C356; instructions for using it are on our website: <http://www.ma.rhul.ac.uk/students/pass> . As a student you can buy a license for using Mathematica on your own computer from the Department Office (please see the website above for details).

### **7.5.1 MINITAB**

The statistical package MINITAB is used in all the statistics halfunits; it is introduced in MT1300. Like Mathematica, it is on the PCs in C103, and on most other PCs around the campus (where you usually enter via Programs-Current Applications). A student version of MINITAB is on sale, from [www.olc.co.uk](http://www.olc.co.uk).

### **7.5.2 Computer Centre training**

As a new student you will take a basic course as part of Induction Week. For all students we strongly recommend that you develop your IT skills, and take some of the Computer Centres courses. [www.rhul.ac.uk/Information-Services/Computer-Centre/training/isis/students](http://www.rhul.ac.uk/Information-Services/Computer-Centre/training/isis/students)

### **7.5.3 Moodle**

Moodle is Royal Holloway's Virtual Learning Environment. Lecturers for most of our courses use Moodle for providing information: course details, announcements, worksheets, project materials, useful links and so on.

### **7.5.4 Computer use and regulations**

Use of the Departments computer facilities is subject to the Computer Centre regulations as listed on the Computer Centre website: <http://www.rhul.ac.uk/Information-Services/Computer-Centre/>.

Please do not disclose your password to anyone or permit anyone else to use your account. Always ensure you have logged off whenever you have finished using a computer. Department print credit will not be refunded if you forget to logout and someone else uses your account. Please note the Department operates a no food or drink policy within the computer labs. Breach of these regulations is treated very seriously and may result in withdrawal of access to facilities.

## **7.6 Library Services**

The Bedford Library is adjacent to the McCrea building and has a full range of relevant mathematics and computer science books and journals. There is an online library catalogue and the Department also subscribes to a number of electronic journals, which students are encouraged to make use of.

## 7.7 Student Counselling Service

The College counselling service is available to all students. To make an appointment either visit FW169, call (01784) 443128, or send an email to [counselling@rhul.ac.uk](mailto:counselling@rhul.ac.uk). The counselling service website is: <http://www.rhul.ac.uk/Counselling/>

## 7.8 The Careers Services

The Careers Office (located in the Horton building) runs job fairs and provides advice and resources about careers. The Department works closely with the College Careers Service, the Departments Careers Officer is Dr. Barnea. The Careers office website is <http://www.rhul.ac.uk/Careers/>

# 8 Equal Opportunities

The University of London was established to provide education on the basis of merit above and without regard to race, creed or political belief and was the first university in the United Kingdom to admit women to its degrees.

Royal Holloway, University of London (hereafter 'the College') is proud to continue this tradition, and to commit itself to equality of opportunity in employment, admissions and in its teaching, learning and research activities.

*The College is committed to ensure that;*

All staff, students, applicants for employment or study, visitors and other persons in contact with the College are treated fairly and have equality of opportunity, without regard to race, nationality, ethnic origin, gender, age, marital or parental status, dependants, disability, sexual orientation, religion, political belief or social origins

Both existing staff and students, as well as, applicants for employment or admission are treated fairly and individuals are judged solely on merit and by reference to their skills, abilities qualifications, aptitude and potential

It puts in place appropriate measures to eliminate discrimination and to promote equality of opportunity

Teaching, learning and research are free from all forms of discrimination and continually provide equality of opportunity

All staff, students and visitors are aware of the Equal Opportunities Statement through College publicity material

It creates a positive, inclusive atmosphere, based on respect for diversity within the College. It conforms to all provisions as laid out in legislation promoting equality of opportunity.

For further details please refer to: <http://www.rhul.ac.uk/College-Profile/equal-opp.html>.

## 9 Course Outlines

### 9.1 MT5400: The Main project

#### 9.1.1 General information

Each student decides on a general area of research. The student should then approach members of the academic staff to ask if they are able and available to supervise projects in this area. If required, the programme director will appoint an appropriate member of the academic staff to be the project supervisor. The project supervisor offers suggestions of research topic and guidance on how to conduct the research. Students are expected to find appropriate references, to assess the importance of the material which they find and to prepare a report on their findings. The report may contain original research or criticism, but this is not obligatory.

The student is expected to

- investigate in depth some branch of mathematics relevant to the general themes of the MSc (namely, Cryptography and Communications);
- write a coherent report on the investigation, with correct referencing, and including an abstract outlining what he or she has done and a concluding section;
- demonstrate that he or she understands what he or she is writing about. The abstract and concluding section must express the students own view and must not be taken from any other source.

The supervisor is expected to

- offer students realistic and self-contained projects;
- assist each student in drawing up a timetable for work on the project and a reading list;
- see students on a regular basis (typically for about 8 supervision sessions), to monitor progress and give advice.

It is expected that during the 2nd term the student will spend quite a bit of time on the project to write the project proposal, and to learn an appropriate wordprocessing system. The majority of work on the main project will take place in the summer after the work for the written examinations has been completed. Students should choose their supervisor and general research topic by the middle of the second term. The Course Director should be informed of this decision and will advise uncertain students. Students must submit a detailed research proposal of about 10 pages by the last week of lectures of the 2nd term. The report on the project, should be word-processed and should be of 25-40 pages long (11pt, normal sized margin).

**Penalties for over-length work:** The College has a common policy on overlength work. For projects in Mathematics this means the following: For every project a recommended page range and an upper page limit is specified. For the MT5400, the MSc project, this is 25-40 pages, (or 10-16,000 words) where it is estimated that about 400 words of text, equations and diagrams are equivalent to one page. The number of pages of your work should normally be within the recommended page range. If the number of pages of your work exceeds the upper page limit of 40 pages by at least 10% and by less than 20%, the mark will be reduced by ten percentage marks, subject to a minimum mark of a minimum pass. For work which exceeds the upper page limit by 20% or more, the maximum mark will be zero. The page count generally includes all tables, diagrams, references, etc. Pages must have normal margins, you must use normal line spacing and text must not be smaller than 11pt.

After consultation with the supervisor you can add further information (like programming code or computer results) in appendices, but such appendices will NOT count towards the marking criteria of the project, if the overall length exceeds 40 pages.

The project must be submitted by **Thursday September 2nd, 2010**, exact hour to be confirmed.

#### **Assessment of the main project**

Each main project is independently marked by two examiners; one of these is normally the project

supervisor. The examiners use the marking scheme below. An external examiner moderates the assessment. The examiners may conduct an oral examination if they wish to check the depth of the student's understanding and to ensure that the report is the student's own work. Projects are assigned a percentage grade according to the marking criteria given in the Programme handbook. A student must obtain a pass grade on the project to pass the degree.

For further details also see the MSc handbook, section 6.

## MSc in Mathematics

### Dissertation Guidelines

You are advised to use Latex or Word for preparing the MSc Dissertation. Latex is particularly suitable for mathematical content, and you are encouraged to learn it. For some help please see <http://www.ma.rhul.ac.uk/latex-help>

The written dissertation should include the following:

- Title page.
- Abstract (or Summary), which explains the aims of the project.
- Introduction to the general subject area and motivation for the project.
- Technical content.
- Bibliography.

Referencing your bibliography correctly is extremely important. Further guidelines will be given, and you should discuss with your supervisor if you have any questions about this.

#### 9.1.2 MSc project marking

A precise description of marking criteria for postgraduate study is available from:

[http://www.rhul.ac.uk/Educational-Development/Centre/all\\_staff/docs/PG\\_Generic\\_Marking\\_Criteria.pdf](http://www.rhul.ac.uk/Educational-Development/Centre/all_staff/docs/PG_Generic_Marking_Criteria.pdf)

Briefly, the criteria define the following percentage grades:

**85-100:** An exceptionally high level of understanding and outstanding research potential.

**70-84.99:** Very high competence and excellent research potential.

**60-69.99:** Evidence of some creativity and independence of thought.

**50-59.99:** Sound understanding of the literature, but lack of accuracy or originality.

**0-49.99:** Insufficient or no understanding of the topic, poor quality of work.

# MSc in Mathematics

## Marking template

### Knowledge of subject (25)

- 21–25: Deep understanding and near-comprehensive knowledge
- 18–20: Deep understanding
- 15–17: Very good understanding
- 12–14: Sound knowledge of relevant information
- 10–11: Basic understanding of the main issues
- 0–9: Little or no understanding of the main issues

### Organisation of material (25)

- 21–25: Of publishable quality
- 18–20: Arguments clearly constructed; material very well-organised
- 15–17: Well-organised; aims met with no significant errors or omissions
- 12–14: Coherent and competent organisation
- 10–11: Lack of clarity in written presentation or aims only partially met
- 6–9: Major flaws in arguments; aims of project not met
- 0–5: Arguments are missing/deficient. Disorganised or fragmentary

### Originality, interpretation and analysis (20)

- 17–20: Significant originality in the interpretation and/or analysis; project aims challenging
- 14–16: Some originality; evidence of excellent analytical and problem-solving skills
- 12–13: Good attempt to interpret and analyse existing literature
- 10–11: Minor flaws in interpretation/analysis of existing literature
- 5–9: Poor interpretation/analysis or project aims too simple
- 0–4: Little or no interpretation or analysis; project aims trivial

### Evidence of reading (10)

- 8–10: Independent reading including research papers
- 6–7: Good use of outside reading
- 4–5: Some evidence of outside reading
- 0–3: Little or no evidence of outside reading

### Bibliography and referencing (10)

- 9–10: Of publishable quality
- 7–8: Good referencing and bibliography
- 5–6: Either poor bibliography or poor referencing
- 3–4: Poor bibliography and little or no referencing
- 0–2: No bibliography and little or no referencing

### Style, spelling, punctuation and grammar (10)

- 9–10: Incisive and fluent, no errors of spelling, punctuation or grammar
- 7–8: Very minor errors of spelling, punctuation or grammar
- 4–6: Some errors of spelling, punctuation or grammar
- 0–3: Many errors of spelling, punctuation or grammar