DEPARTMENT OF MATHEMATICS

POSTGRADUATE TAUGHT
STUDENT HANDBOOK

2018/2019

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Department Mathematics
School of Information Security and Mathematics
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 An electronic copy of 2018/2019 handbook can be found here:-
https://intranet.royalholloway.ac.uk/mathematics/documents/pdf/pg/maths-pgt-handbook-2018-19.pdf
where it will be possible to follow the hyperlinks to relevant webpages.

Contents

1   Introduction to your Department

1.1 Welcome

Welcome to Royal Holloway. Royal Holloway, University of London (hereafter 'the College') is one of the UK's leading research-intensive universities, with nineteen academic departments spanning the arts and humanities, social sciences and sciences.

Welcome to the Department of Mathematics.

This booklet contains important information for graduates registered for a taught degree programme in Mathematics; please read it carefully.

The Department complies 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 a Code of Practice. In the case of any apparent difference, the College regulations will prevail.

A satisfactory programme of study at university requires students and the Department to enter an informal `contract' of obligations and expectations by which all should abide.
What you can expect from us:

The Mathematics Department is committed to effective teaching, but we judge our success in terms of how well you learn. We will do all we can to stimulate your interest in Mathematics, to make the aims of each course clear, to train you by means of interesting coursework and projects, to provide appropriate support, and to monitor and guide your progress. We hope our enthusiasm for the subject will prove infectious and will motivate you to pursue your studies energetically. Most of all, we hope you will find the Department a friendly, supportive and inspiring place in which to work.

You can expect the Department to:

- provide lectures and projects in a series of course units which will make up your degree programme;

- help finding a research topic and a supervisor for your dissertation;

- take reasonable steps to assist students who are disadvantaged through illness or other problems;

- nominate a personal adviser who will act as your point of contact with the Department;

- assess and examine your work;

- provide verbal or written feedback on coursework and drafts of your dissertation where appropriate;

- provide a feedback mechanism for student evaluation of courses through questionnaires;

- provide reasonable notice of all coursework deadlines at lectures or electronically;

- Treat all students in a fair and just manner without any form of prejudice.

What we expect from you:

Your degree course should challenge you to deal with difficult concepts, to become skilled in new and demanding techniques, and to push your intellectual powers to the limit. If not, then you will not have used your opportunity to the full. The MSc and PgDip 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, as appropriate. Students who successfully complete the programme will be prepared for research or professional employment in these areas.

Employers and PhD supervisors are not only interested in the knowledge you have acquired, though knowledge is obviously relevant to careers in mathematics. They are also interested in personal qualities like self-reliance and initiative, and in your capacity to think rationally and independently, to work in a team, to write clear reports within a firm deadline, and so on.

These qualities cannot be taught. They depend on many factors, among them the energy you put into your studies and the drive with which you pursue your career goals. We want you to enjoy your studies and your time here; when you enjoy what you do, you will work harder and learn more effectively.

You will be expected to:

- attend all lectures, workshops and tutorials;

- keep your personal adviser fully informed of any problems which may affect your studies;

- complete all coursework and attend all examinations;

- hand in coursework by the set deadline;

- fill in all course questionnaires (anonymously) and provide constructive feedback;

- check your College e-mail daily;

- check your Moodle course pages regularly;

- always behave in a manner which reflects well on the Department and the College.

1.2 How to find us: the Department

The Department of Mathematics is located in the McCrea Building, at the centre of the Campus and close to the spectacular Founder's Building. This can be found on the College **campus map** as Building 17

1.3   Map of the Egham campus
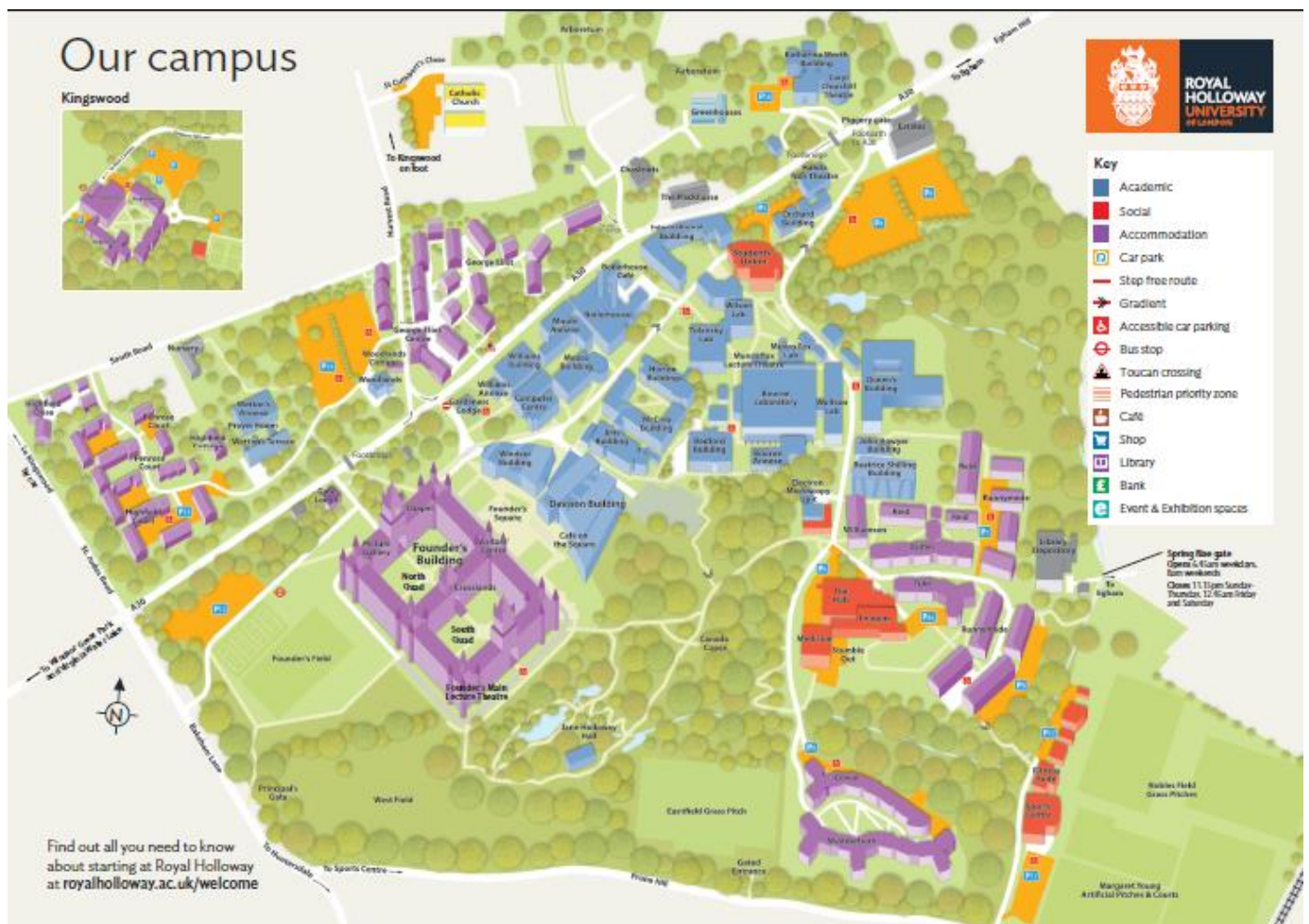
Please note, student parking is very limited and is not available if you live in Halls or within 1.5 miles of campus. If you do live more than 1.5 miles away or have a particular reason why you need to come to campus by car, you must apply for a parking permit. If you have a motorbike or scooter you must also register the vehicle with College. Find more information about the Parking Permit portal here.

1.4 How to find us: the staff

Academic staff all have offices in the McCrea Building. You should only visit them during their office hours; these are posted on the door of their office and on the Department's website. If you cannot visit during office hours, please email the staff member asking for an appointment and saying when you are free. There is a staff list with office information on the Department's website, and in the foyer of the McCrea Building.

If you have problems, the following list shows whom to contact:

- **Course units –** the lecturer
- **Course selection** – your personal adviser
- **Your degree programme –** your personal adviser and the MSc Programme director
- **A personal problem –** your personal adviser, or the Welfare Services   (Counsellors, Health Centre, Chaplaincy, Student Union)
- **A problem common to other students –** the lecturer, your Student-Staff   Committee representative
- **College registration, enrolment, fees, accommodation, loans etc. –** the   Student Administration Centre

KEY CONTACT DETAILS

Head of Department:	Telephone	Room
Professor Ruediger Schack R.Schack@rhul.ac.uk	01784 443097	McCrea 245
MSc Programme Director Dr Teo Sharia t.sharia@rhul.ac.uk	01784 414331	McCrea 236
School Manager Ms Jo Hible jo.hible@rhul.ac.uk	01784 443230	McCrea 120
Senior Postgraduate Administrator Alex Hale Alexander.Hale@rhul.ac.uk	01784 276769	McCrea 119
Disability & Dyslexia/Support Services Coordinator Alex Hale Alexander.Hale@rhul.ac.uk	01784 2736769	McCrea 119
Computer Technical Support cimhelpdesk@rhul.ac.uk	01784 443443	

Personal Advisor: You will be allocated a Personal Advisor during Induction Week (see note 3.5 for the role of Personal Advisors).

1.5 How to find us: the Departmental Office

The Departmental Office is located in McCrea 119. The Departmental Office is open Monday to Friday during term time from 08.30 am to 16.30 pm. You can also phone the Office on 01784 276769/07184 443091 or you can email maths@rhul.ac.uk

1.6 The Department: practical information

Safety. Please make yourself aware of the procedure for fire evacuation. The Mathematics Assembly Point is between McCrea and Horton at Fire Assembly Point 11.

Smoking. Please note that smoking is not allowed in the McCrea Building.

1.7 Staff research interests

The research interests in the Department include information security, cryptography, coding theory, algebra, number theory, graph theory, the mathematics of atomic processes, quantum theory, quantum https://pure.royalholloway.ac.uk/portal/en/organisations/departmentof-mathematics%287ff3623d-1e5a-45d1-8ab1-6929b58c0f0b%29.html

2 Support and Advice

2.1 Student Charter

The College aims to bring all students into a close, harmonious relationship with each other and with the wider community. The Student Charter outlines how you can support the College in achieving these goals and also seeks to encourage you to act as an effective ambassador for the College, during your time as a student and later as part of the College's alumni

This Charter is not intended to constitute a binding agreement but is offered as a framework of aspirations, designed to be of benefit primarily to you as a student and to underpin the College's aim of ensuring that you have a highly enjoyable and rewarding experience during the course of your degree.

2.2 PGT Degree Regulations

The Postgraduate Taught Regulations set out the various standards that shape the regulatory framework of your Postgraduate Taught degree with the College. These include a variety of essential information, ranging from admissions to academic progression and examination. Some frequently used elements of the regulations are covered in this handbook.

2.3 Support within your department

Your points of contact for advice within the Department is the Maths Postgraduate Administrator, your personal advisor or the Programme Director. Inevitably, problems will sometimes arise that the Department is not qualified to deal with. The College offers a high level of student welfare support, which includes a highly regarded Counselling Service, dedicated educational and disability support, as well as a wealth of student wellbeing, financial, career and other advice. There is also an NHS GP practice (the Health Centre) on campus located in Founder's East. Further details of each service can be found on the College web on the Student Welfare page.

If you have a disability or specific learning difficulty, it is important that you bring it to our attention as soon as possible. The Disability and Dyslexia Services Office (DDS) representative is the Mathematics Undergraduate

Administrator – Miss Valerie Nicol. You must also contact the DDS (Founder's West 143; Tel: +44 (0)1784 276473; Email: disability-dyslexia@royalholloway.ac.uk) who will advise on appropriate sources of help.

2.4 Students' Union Royal Holloway University of London (SURHUL)

The Students' Union Royal Holloway University of London (SURHUL) is a registered charity (Registered No: 1141998) and actively represents the students of Royal Holloway University of London. SURHUL promotes your needs and interests by offering employment, participation, entertainment, support and advice, your clubs and societies, catering, transport, volunteering, campaigning and advocacy.

The SU Advice and Support Centre, situated on the first floor of the Students' Union, is a free service that offers you the opportunity to discuss any concerns you may have and receive impartial advice and information from the team of experienced and professional advisers. Open 9.30am - 5pm, Monday – Friday, it operates an open door policy exclusively for students during term time. However, during vacation periods students should call to book an appointment.

Phone: 01784 24 6700
Email: helpdesk@su.rhul.ac.uk

Find out more about the Students' Union

2.5 Student-staff committee

We want to hear your views on the way the department operates. Course representatives are elected by you to represent your views and ultimately, to help improve the quality of education provided by the College.

The Students' Unions take the lead in training and supporting course representatives, working with the department and professional services to help you make as many positive changes as possible.

The Student- Staff Committee meets at least once a term and plays an important role in the department as a forum for airing student views. For more information see the Course Reps page on the SURHUL website.

You can use the Committee to raise any issues which concern students. Notices will appear on departmental notice boards giving details of forthcoming elections or the names of current representatives.

2.6 Student Services Centre

The Student Services Centre is located in the Davison Building and provides a single point of contact for all non-academic related queries including accommodation, fees, enrolment and graduation.

Phone: 01784 27 6641
Email: studentservices@royalholloway.ac.uk

Find out more about the Student Services Centre

2.7 Support Advisory & Wellbeing

The College offers a high level of student wellbeing support which includes triage and support through Student Wellbeing, a BACP accredited Counselling Service, dedicated disability & dyslexia support, financial and budgeting advice and support for international students. There is also access to an NHS run Health Centre on campus.

Phone: 01784 44 3394
Email: wellbeing@royalholloway.ac.uk

Find out more about Support Advisory & Wellbeing

2.8 Student Wellbeing

Student Wellbeing provides advice and guidance to all students on personal and emotional wellbeing, to assist you in maintaining a healthy balanced lifestyle and to support you from transition to university and then in the continuation of your studies towards graduation. The Student Wellbeing team actively encourages all members of the campus community to alert them to concerns or signs of vulnerability to enable proactive engagement with intervention.

Phone   01784 44 3395 / 44 3132 / 27 6757
Email: wellbeing@royalholloway.ac.uk

Find out more about Student Wellbeing

2.9 Disability & Dyslexia Services (DDS)

If you have a disability, long standing medical condition or specific learning difficulty, it is important that you bring it to the College's attention as soon as possible.

The College Disability & Dyslexia Services support dyslexic and disabled students and those with mental health or chronic medical conditions to demonstrate their academic abilities by arranging support packages, dyslexia assessments and study skills sessions.

Phone: 01784 27 6473
Email: disability-dyslexia@royalholloway.ac.uk

Find out more about Disability & Dyslexia Services

Your first point of contact for advice and guidance is your Disability & Dyslexia Services Network Member in your department:

Name: Alex Hale
Phone: 01784 276769
Email: alexander.hale@rhul.ac.uk

2.10 International Student Support Office (ISSO)

The International Student Support Office offers advice to international students on visa issues, working in the UK, opening a bank account, processing federal loans and police registration.

Phone: 01784 27 6168
Email: internationaladvice@royalholloway.ac.uk

Find out more about the International Student Support Office

2.11   Academic Skills Support

The Centre for the Development of Academic Skills, CeDAS, offers a variety of courses, workshops, 1:1 tutorials, online resources that aim to ensure all students at Royal Holloway reach their full academic potential in a range of areas, including academic writing, oral communication skills and maths and statistics.

Whatever your needs, CeDAS is there to ensure that you can perform to the best of your ability, whether it be through a workshop that introduces you to a crucial academic skill, a session within your department that focuses on writing in the discipline, a course that develops your confidence and competence in academic English language, or a 1:1 tutorial

with a specialist to help you master a maths technique or sharpen your essay skills.

The Centre also oversees the Royal Holloway Proofreading Scheme, which enables postgraduate students to pay for an approved third-party proof-reader to identify surface error in final drafts. Please note that Royal Holloway does not permit the use of paid third-party proof-readers who are not part of this scheme.

The CeDAS Office can be found on the ground floor of the International Building, room IN002, and you can follow them on Twitter: @cedasrhul. More details can be found here: https://intranet.royalholloway.ac.uk/ecampus/cedas/contact-us.aspx

2.12   IT Services Desk

The College IT Service Desk offers a range of support covering all aspects of IT services, such as email access, connecting to the College's wireless network, connecting devices such as iPads and making use of College printing facilities. The IT Service Desk will also be able to provide expert advice and guidance on a range of more specific IT issues, should you experience any problems. They also offer a range of free software, including Microsoft Office 365, Sofos Antivirus, NVivo and SPSS.

Phone: 01784 41 4321
Email: itservicedesk@royalholloway.ac.uk
In person: Visit the IT support office in the Davison Library (ground floor)

Find out more about IT Services

3   Communication

It is vitally important that you keep in touch with us and we keep in touch with you. Members of staff will often need to contact you to inform you of changes to teaching arrangements, special preparations you may have to make for a class or meetings you might be required to attend. You will need to contact members of the Department if, for example, you are unable to attend a class, or you wish to arrange a meeting with your Personal Tutor.

3.1   Email

The College provides an email address for all students free of charge and stores the address in a College email directory (the Global Address List). Your account is easily accessed, both on and off campus, via the campus-wide portal, CampusNet, or direct via Outlook.com.

We will routinely email you at your College address and you should **therefore check your College email regularly** (at least daily). We will not email you at a private or commercial address. Do not ignore emails from us. We will assume you have received an email within 48 hours, excluding Saturdays and Sundays.

If you send an email to a member of staff in the department during term time, you should normally receive a reply within 3-4 working days of its receipt. Please remember that there are times when members of staff are away from College at conferences or undertaking research.

3.2   Post

All post addressed to you in the Mathematics Department is delivered to the student pigeonholes (alphabetical by surname) in the foyer on the 2nd floor. At the end of each term, student pigeonholes are cleared of accumulated mail, which is then destroyed. Important information from Academic Services is often sent by internal post and tutors sometimes return work to you via the pigeonholes so you are advised to check them regularly.

3.3   Your Contact Information

There can be occasions when the Department needs to contact you urgently by telephone or send you a letter by

post. It is your responsibility to ensure that your telephone number (mobile and landline) and postal address (term-time and forwarding) are kept up to date. Further information about maintaining your contact information is available here.

You can find out about how the College processes your personal data by reading the Student Data Collection notice.

3.4 Notice boards

The official student notice boards are on the walls in the foyer of the McCrea building. There is a noticeboard especially for MSc students in McCrea between rooms MC250 and MC253. Every effort is made to post notices relating to class times well in advance, but occasionally changes have to be made at short notice and in that case, email will be used.

It is your responsibility to check the times and venues of all class meetings and of any requirements (e.g. essay deadlines) relating to your courses, so, if in doubt, please ask!

3.5 Personal Tutors

Each student has a Personal Adviser. The Personal Adviser may help with course choices and with finding a dissertation topic and supervisor. The Adviser provides a point of contact between students and the Mathematics Department.

3.6 Questionnaires

Towards the end of each teaching term there will be a questionnaire for each course. At the end of the programme we will ask the students to fill out a questionnaire to evaluate the entire programme

4 Teaching

4.1 Dates of terms

Term dates for the year are as follows.

Autumn term: Monday 24 September 2018 to Friday 14 December 2018
Spring term: Monday 14 January 2019 to Friday 29 March 2019
Summer term: Monday 29 April 2019 to Friday 14 June 2019

You are expected to be in the UK and engaging with your studies during term time. In the case of an emergency which requires you to leave the country and/ or miss lectures/ seminars/ practicals etc., you are expected to inform your department and fill in a Notification of Absence Form (explained further below). During the summer term, after the examination period, you are expected to attend all required academic activities organized by the department and to be available should you be required to meet with College staff for any reason.

Furthermore, as Master's programmes run for one calendar year from September to September you are required to engage with your studies and be available to meet with staff after the end of the Summer Term until your programme end date in September. For Master's programmes there is no summer vacation period.

4.2 Academic Timetable

Your individual student timetable will be available via the Your Timetable page on the Student Intranet. Log in with your College username and password and view your timetable via the system or download to a personal calendar. In September you will receive communications by email about exactly how to access and download your timetable, so

keep any eye out for these. Timetables are subject to change during the course of the academic year, so you should check yours regularly, (as a minimum every few days) to ensure you are using the most up to date timetable. Any changes to your timetable that occur within two working days will be notified by email to your RHUL account, so please also check your emails regularly. All classes start on the hour. They end ten minutes before the hour to allow you to move between classes.

4.3 Study weeks

The Mathematics Department does not have study weeks. You are expected to attend classes and submit work throughout the term (**and this applies even if you are taking some courses in departments with study weeks)**

5   Attending classes and engaging with your studies

The College has a responsibility to ensure that all students are attending classes regularly and progressing with their studies. We also have legal obligations placed on us under the Equality Act (2010), UK Visa and Immigration (UKVI) and Student Finance to ensure we monitor your attendance and engagement with studies.

Your regular attendance in class and consistent engagement with your studies are essential to your learning experience with the College. If you encounter difficulties with this, do please tell your tutor or another member of staff as soon as you can. The earlier you do so, the sooner we can provide the appropriate help. As such, failure to attend and/or absence without permission can result in serious consequences and may lead to disciplinary action, including the termination of your registration.

5.1   Attendance requirements

Your classes are the learning activities deemed essential to your programme of study. These could include a variety of different activities, including lectures, seminars, tutorials, workshops, fieldwork, laboratory work, and meetings with your Personal Tutor.

While you are expected to attend all the classes related to your programme of study, the College understands that emergencies may occur at any time throughout the year. In light of this, the Mathematics Department has set a minimum attendance level at 80%. You should be aware that you may also study courses that have different and specific course attendance requirements, particularly if you are taking courses in another department, so it is essential that you check all programme and course handbooks to ensure you are fully aware of the requirements. You can find out more about attendance policy here.

It is vital that you manage your time effectively, so that any paid employment, voluntary work, extracurricular activities or social commitments do not interfere with periods where you are required to attend classes. The Postgraduate Taught Programme Regulations stipulate that the amount of paid work undertaken by a student enrolled with the College on a full-time basis must not exceed 20 hours per week during term time. You may not undertake paid work which may conflict with your responsibilities as a student of the College. International students must ensure that any working restrictions, as stated on their visa, are also adhered to.

5.2   Adjustments to attendance requirements

If you are experiencing difficulties on an ongoing basis, please contact your Personal Tutor or
Dr. Teo Sharia. If you believe that you will not be able to comply with the attendance requirements, you may request an adjustment in your case. This would only be permitted if you have good reason to ask for it and if adjustment would not compromise competence standards or your ability to reach the learning outcomes of your programme. Requests to consider an adjustment to attendance requirements will be treated case by case and discussed by the department with the Disability and Dyslexia Services (D&DS) and Academic Quality and Policy Office (AQPO).

5.3   Monitoring attendance

The Mathematics Department will monitor your attendance at lectures, workshops and tutorials. It is your

responsibility to make sure that your attendance has been recorded. It is also essential that you arrive at your classes in good time, as you will be marked absent if you turn up late without good reason.

We will contact you in the event that:

     i.   you fail to attend for **two weeks** without providing notification of your absence;
    ii.   you display a **pattern of absence** that the department feel is affecting or is likely to affect your work
   iii.   you display a pattern of absence that causes **concern over your wellbeing or which may point to an undisclosed disability**

5.4 Formal Warnings

Should it become apparent that there are no acceptable reasons for your non-attendance and/or general lack of engagement with your studies, the Department may issue you with a formal warning which can escalate to the termination of your registration at the College. You are strongly advised to read the guidance on the formal warning process and the consequences of receiving such a warning in section 17 of the Postgraduate Taught regulations.

In situations where you are experiencing documented severe difficulties the Department and College will make every effort to support you and counsel you as to the best course of action.   However, there may be cases where, although non-attendance is explained by an acceptable reason, your level of attendance falls to a level which compromises educational standards and/or your ability to reach the learning outcomes of the course. In such cases it will be necessary to implement disciplinary procedures as detailed above.

5.5 Withdrawal of visa

If you are sponsored by Royal Holloway on a Tier-4 (General) Student visa, should your registration at the College be terminated for non-attendance, general lack of engagement with your studies or any other disciplinary matter you will be reported to the UK Visa and Immigration (UKVI) and your Tier 4 (General) Student visa will be withdrawn. Alternatively, in line with the College's legal obligations to UKVI, if you fail to meet the requirement of your Tier 4 (General) Student visa, including attendance and completion of assessments, the College may terminate your student registration without following the disciplinary procedures outlined in the Academic Regulations. This decision would not be open to appeal as it is part of the College's obligations to the UKVI. Please see our Postgraduate Taught Regulations.

5.6 Missing classes

If you face difficulty in attending any classes or undertaking an assessment it is very important that you inform the department as early as possible, giving the reasons for your non-attendance. The department will decide whether or not to authorise your absence. If you are experiencing such difficulties on an ongoing basis, please contact your Personal Tutor. In addition, an extensive range of additional support, guidance and advice is available from the College's Student Advisory & Wellbeing teams. As explained in section 2 above, the Students' Union also operate an Advice and Support Centre.

If you are unable to attend classes for whatever reason you must tell the department in which you are taking the course(s) in question and follow the Notification of Absence Procedure. You must submit a Notification of Absence Form together with any supporting documentation either before your absence begins or within five working days of the end of the period of absence to mathsattendance@rhul.ac.uk . The exact form to submit depends on the reason for your absence, as explained in the on line guidance.

If you are absent for a prolonged period it is essential that you keep in touch with the Department (e.g. through regular emails with your Personal Tutor). The Department will monitor the frequency of self-certified absences and the Head of Department may request a doctor's medical certificate from you in the event of multiple and/or sustained instances of self-certified illness. If you are sponsored by Royal Holloway on a Tier-4 (General) Student visa please be aware that if you do not follow the process to submit a notification of absence or have an acceptable reason for

absence you are putting your Tier 4 visa at risk of withdrawal. Therefore, it is very important that you continue to communicate with the College through your Department and the Advisory & Wellbeing teams if you are struggling to attend.

5.7 Missing an examination

If you are unable to attend an exam (e.g. through reasons of sudden illness) then there are two steps to follow.

Step 1
You must notify the Student Services Centre at the earliest possibility. Wherever possible, please e-mail them at studentservices@royalholloway.ac.uk before the scheduled start of the exam with your name, student ID and confirmation of the exam that you are unable to attend. Please include a brief explanation within the email why you cannot attend the exam. The Student Services Centre will then forward this information to your department so that we are aware of your non-attendance.

Step 2
It is essential that you inform your department and Chair of the Sub-board of Examiners by completing the Extenuating Circumstances form. For further information, please refer to section 8 below.

6 Degree Structure

Full details about your programme of study, including, amongst others, the aims, learning outcomes to be achieved on completion, courses which make up the programme and any programme-specific regulations are set out in the programme specification available through the Programme Specification Repository.

6.1 Department Specific information about degree structure

The full time MSc lasts for 50 weeks, from late September until beginning of September of the following year. The full time PgDip lasts from late September until early June of the following year.

The MSc is examined in two parts; by written examination (mainly in May), and by a dissertation on a main project to be submitted early in September. This is called the main project to distinguish it from any projects that form part of a course unit. The PgDip has the same course structure but there is no main project.

Students initially choose 8 courses of which they specify 6 courses (20 credits each) during the second term that will count towards the examination. The two unspecified courses are `Supplementary'. Supplementary courses appear on students' transcripts but do not contribute to the final degree classification.

The 6 specified courses carry 20 credits each. The main project carries 60 credits, so that each MSc student will be registered for 6×20+60=180 credits and PgDip students will be registered for 6×20=120 credits.

Students write at least the 6 examination papers of their specified courses but may choose to write examination papers in their supplementary courses in addition. The marks for the supplementary courses will appear on their transcript but do not count towards the degree classification.

A standard part time MSc programme lasts for 102 weeks, from September to September two years later. Part-time Masters Students are typically expected to take four course units in their first year (typically the core courses would be taken in the first year) and complete the remaining courses and the dissertation in the second year. Part-time students following the standard 2year part time model will be encouraged to begin work on their dissertation during the summer between their first and second years. Part time students are permitted under College regulations to complete their programme of study over a period of up to 5 years. Students who are unable to complete the programme within the standard 2 year timeframe should liaise with the programme director to agree a time frame for completion.

The Examinations office will probably ask you to specify the examination papers that you intend to write very early.

The reason is the involved exam timetable. In the past, the department was able to negotiate a later deadline, watch out for information (by email) from the programme director. Full details about your programme of study, including, amongst others, the aims, learning outcomes to be achieved on completion, courses which make up the programme and any programme-specific regulations are set out in the programme specification available through Programme Specification Repository.

6.2 List of Courses

Core Courses on the MSc Mathematics for Applications

Code	Title	Term	Lecturer
MT5400	Main Project	Summer	

Core Courses on the MSc Mathematics of Cryptography and Communications

Code	Title	Term	Lecturer
MT5400	Main Project	Summer	
MT5441	Channels	1	Dr Kay
MT5462	Advanced Cipher Systems	1	Professor Wildon
MT5461	Theory of Error Correcting Codes	2	Dr Ng
MT5466	Public Key Cryptography	2	Professor Audenaert

Other Courses

Code	Title	Term	Lecturer
MT5432	Inference	1	Dr Sharia
MT5441	Channels	1	Dr Kay
MT5454	Combinatorics	1	Professor Dietmann
MT5462	Advanced Cipher Systems	1	Professor Wildon
MT5485	Applications of Field Theory	1	Dr Widmer
MT5412	Computational Number Theory	2	Dr Widmer
MT5414	Principles of Algorithm Design	2	Professor Blackburn
MT5436	Applied probability	2	Dr Koloydenko
MT5445	Quantum Information and Coding	2	Dr Kay
MT5448	Advanced Financial Mathematics	2	Dr Shcherbakov
MT5461	Theory of Error Correcting Codes	2	Dr Ng
MT5466	Public Key Cryptography	2	Professor Audenaert
MT5491	Topology	2	Professor Nucinkis

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, MT5432 and MT5436. Ask the lecturer for details.

This booklet gives descriptions of all postgraduate (MT5xxx) courses. Note that many of these courses are related to the corresponding third year and fourth year (MSci) courses and the corresponding course numbers are different but related: for example MT5485 (MSc) is related to MT4850 (MSci) and MT3850 (BSc).

The following final year undergraduate, and MSc courses may be relevant. The syllabi are on the web sites:

https://www.royalholloway.ac.uk/mathematics/informationforcurrentstudents/nextyearcourses/201415undergraduate.aspx and
https://www.royalholloway.ac.uk/isg/informationfornewreturningstudents/ms csyllabus.aspx

Code	Title	Term
MT3200	Quantum Theory 1	1
MT3220	Dynamics of Real Fluids	2
MT3340	Time Series Analysis	1
MT3470	Mathematics of Financial Markets	1
MT3110	Number Theory	1
MT3280	Non-Linear Dynamical Systems	1
MT3860	Groups and Group Actions	2
IY5511	Network Security	1
IY5512	Computer Security	1
IY5604	Database Security	2
IY5605	Cyber Crime	2
IY5607	Software Security	2

6.3 Course choices

Each student should attend lectures on 8 taught courses. MSc students write a dissertation in addition.

For the Cryptography and Communications programme, the eight taught courses   should include the core courses listed above. 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). Recommended optional courses for the MSc of Cryptography and Communications are Applications of Field Theory (MT5485), Computational Number Theory (MT5412), Combinatorics (MT5454), and Principles of Algorithm Design (MT5414).

Students on the MSc Mathematics for Applications may choose from the whole range of MT5xxx courses.

A student may also, in agreement with the Programme Director, choose courses from the third year options of the undergraduate degree programme in Mathematics (MT3xxx range), and from the list of MSc courses in Information Security (IY5xxx range). Normally, permission will only be given if the material has not been covered as part of their previous studies. Note that these courses can only be taken as `supplementary', and the marks obtained in such courses cannot be included in the calculation of the degree classification.

All MSc students (but not PgDip students) will do a main project, which is a major piece of independent study. This project work will be undertaken under the supervision of a member of staff. The assessment will be on the basis of a written dissertation; the examiners may also at their discretion require an oral examination. Please refer to Section 8.2 for more information on the dissertation. The dissertation must be submitted by the first Thursday of September of the calendar year of completion of the written part of the examination by 2pm (14:00).

The final assessment is based on the courses and dissertation listed above.
- 66.7% of the assessment is taken to be the average mark of the six weighted taught courses. The six weighted taught courses over which the marks are averaged must all be of Masters Level.
- 33.3% of the assessment is on the written dissertation.

6.4 Course registrations

 You have the option of changing course unit registrations within the first two weeks after the start of teaching (excluding Welcome Week) subject to agreement from the department. Any courses that you wish to take on an extracurricular basis (that is, as extra and not counting towards your degree) must be identified at the start of the academic year or before any assessment has been completed for the course.

6.5 Change of programme

You may apply to transfer from one programme to another within the common curriculum where provision is made for this in the programme specification.

Further information about changing programmes is available in Section 8 of the Postgraduate Taught Regulations.

7   Facilities

7.1 The Library

The Library is housed in the **Emily Wilding Davison Building**.

Details, including Library Search, dedicated subject guides and opening times can be found online from the Library home page.

The Ground Floor of the Library contains a High Use Collection which includes many of the books assigned for Postgraduate Taught courses. . The rest of the Library collections are on the upper floors. There are plenty of study areas and bookable rooms to carry out group work, as well as many areas to work on your own. The Library contains a large number of PCs and has laptops to borrow on the ground floor to use in other study areas.

If you cannot find the specific items that you require in the library, it is possible order an Inter-Library Loan or to gain access to the online resources of Senate House Library as well as access to use the library's physical collections or other university libraries.

The Library provides a range of training sessions designed to enhance your existing library and research skills. These are available in both class-based and self-study formats. For information on available sessions and to book a place, go to:-
http://libguides.rhul.ac.uk/training

The Information Consultant for Mathematics is Leanne Workman, who can be contacted at
Leanne.Workman@rhul.ac.uk

7.2 Photocopying and Printing

The departmental printers and photocopier are reserved for staff use. Copier-printers (MFDs) for students are located in the Library, the Computer Centre and many PC labs, which will allow you to make copies in either black and white or colour. Further information is available here:

If you require copying to be done for a seminar presentation, you need to give these materials to your tutor to copy on your behalf. Please make sure that you plan ahead and give the materials to your tutor in plenty of time. Many of the PC labs are open 24 hours a day, 7 days a week. Alternatively, there are computers available for your use in the Library, and Computer Centre.

You will be given a department printing allowance at the start of session 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 the departmental allowance is used in preference to any personal credit you may have. 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. Departmental staff are unable, in any circumstances, to print anything out on your behalf.

7.3   Computing

There are ten open access PC Labs available on campus which you can use, including three in the Computer Centre. For security reasons access to these PC Labs is restricted at night and at weekends by a door entry system operated via your College card. The Computer Centre provides a range of IT training sessions designed to enhance your current IT skills. These are available in both class-based and self-study formats, and successful completion of the course is rewarded by a College IT Skills certificate. To participate in these sessions, go to:
http://www.royalholloway.ac.uk/it/training/home.aspx

How to find an available PC

The department has a PC lab in C103 (shared with the Computer Science Department) which is available for use when not booked for teaching, please check the timetable on the door. Outside of working hours, you may access the lab using your college card. Please note the Department operates a no food or drink policy within the computer laboratories. Breaches of these regulations are treated very seriously and may result in withdrawal of access to facilities.

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

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.
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, for example previous exams, are at
http://www.ma.rhul.ac.uk/static/PastExams/

Calculators in Examinations

The following calculator is approved by the Department for use in the exams: **Casio FX-83GTPlus**

Your calculator must have a MT sticker on it which can only be affixed by the Maths Admin Office (located in McCrea room 118). If you have lost your calculator you can purchase a new one from the Maths Admin Office for £5. Please also note that spares are not allowed. This means you will not be allowed to use any other calculator apart from the ones approved by the Maths Department and if you forget it on the day of the exam, the invigilators are not allowed to issue any spares, so please do not forget yours!

8   Coursework Essays and Dissertation

8.1 Coursework

There are homework exercises for each course. These are available on the course page on Moodle. Each lecturer will specify when and how the homework has to be submitted. The homework exercises are marked but these marks do not contribute to the final grade for the 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 solve every exercise on every sheet.

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.

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

8.2 The dissertation

The dissertation accounts for 33.3% of the assessment for the MSc degree. Two bound hard-copies of the dissertation have to be submitted to the administrators in McCrea 119 by 2pm on the first Thursday of September in the year of the written examination. You should plan 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 until beginning of September (unless you have part time status) and that you are not supposed to take on any commitment during the summer that prevents you from spending most of your time on the dissertation.

In Term 2, there will be a training session to provide guidance on the project, with particular emphasis on mathematical writing and on plagiarism. You can find some resources including a LaTeX template here - http://www.ma.rhul.ac.uk/~uvah099/Maths/ProjectAdvice.pdf

Students are advised to use Latex or Word for preparing the MSc dissertation. Latex is particularly suitable for mathematical content and we encourage the use of it. For some help please see http://www.ma.rhul.ac.uk/latex-help

8.3 Choice of dissertation topic

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.

8.4 The dissertation supervisor

Your department will assign you a dissertation supervisor who will oversee your work. In most cases students are happy with the supervisory relationship. However, there are occasions where for some reason the supervisory relationship does not work and breaks down. If this happens, you should speak as soon as possible with the Programme Director or your Personal Tutor to see whether the problem can be resolved informally, e.g. through mediation, changing supervisor. You should not wait until after you have received your final degree results to raise the matter as it is very difficult for the College to resolve such matters or take remedial action at that point.

Course lecturers, the adviser and the programme Director may help in suggesting research areas and finding a supervisor. The supervisor will help the student to find a specific topic in the area of the student's interest. Note that students are not guaranteed the supervisor of their choice, though we try to ensure that all students have a supervisor

who is willing to supervise the student's chosen topic. If you are unable to find a supervisor or a research area then you should see the programme Director during the first half of term 2.

8.5 Proposal

By the end of term 2 (last week of lectures) students should produce a brief research proposal, of 5-10 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 compulsory part of the dissertation. Failure to complete a satisfactory proposal may result in the student being moved from the MSc programme to the PgDip.

8.6 Content of dissertation

The final part of the main project is to prepare the dissertation. It is important to allow plenty of time for this stage (typically at least one month). It is usually best not to leave writing of the entire dissertation to the end but to write parts of it during the summer. Usually your supervisor will read one draft version, (but will not usually read the same chapter several times) if it is given to her/him in good time. The students may want to give draft parts to the supervisor at earlier stages and not the entire dissertation towards the end of project.

8.7 Presentation
The dissertation must include:

- Title page.
- Abstract (or Summary), which explains the aims of the dissertation and summarises the results.
- An introduction which outlines and motivates the topic of the thesis.
- 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.
- Conclusions which describe how the results relate to the wider subject area and/or suggests some possible future lines of enquiry.
- Bibliography

8.8 Footnotes
In addition to the text, the word count should include quotations and footnotes. Please note that the following are excluded from the word count: candidate number, title, course title, preliminary pages, bibliography and appendices.

8.9 Bibliography
It is crucial to properly acknowledge other people's work. The bibliography usually consists of a list of publications in alphabetical order of the author's names. Each entry contains at least the author's names, the title of the publication, the journal, publisher or website, the year of publication and in case of a journal article, the volume and the page numbers of the entire article. It is unusual to quote verbatim in mathematics (apart from definitions, lemmas and theorems), and one usually refers to the entire article if one is using a result of it. Sometimes when citing long articles or books it is helpful if one refers to a particular theorem. If you use material from websites you must reference the sites.

The supervisor will give feedback on your citing, referencing and the bibliography if she/he is given a draft.

8.10 Referencing style, Illustrations and Appendices

In Term 2, there will be a training session to provide guidance on the project, including referencing styles, illustrations, and appendices, with emphasis on mathematical writing and on plagiarism.
You can find some resources including a LaTeX template here -
http://www.ma.rhul.ac.uk/~uvah099/Maths/ProjectAdvice.pdf

8.11 Word Count
The dissertation is usually of length between 8,000 and 16,000 words. The margins should be at least 2cm wide and the font size 11pt. Two bound hardcopies of the thesis have to be submitted. You can find some of the dissertations by students of previous years in the Admin Office C119 to get an idea how they look like.

8.12 Marking criteria
Each dissertation is independently marked by two examiners; one of these is normally the supervisor. 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 dissertation is the student's own work. **Student must obtain a pass grade on the dissertation to pass the MSc degree**. The examiners give up to 100 points where the points translate to the following categories:

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.

The points are given according to the following guidelines:

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

9   Assessment Information

9.1 Anonymous marking and cover sheets

All work that is submitted for assessment is marked anonymously. The only exception to this is the main project.

9.2   Submission of written work

Usually homework assignments are collected during lectures but some lecturers may have different arrangements of which they will inform the students at the beginning of the course. The dissertation resulting from the main project must be given to the administrators in MC119 during the office hours by 2pm on the first Thursday of September in the year of the written exams.

9.3   Extensions to deadlines

An extension to a deadline can only be given if there are extenuating circumstances. A written request to extend the deadline must reach the Programme Director before the deadline.

Work submitted after the published deadline will be penalised in line with Section 13 (5) of the College's Postgraduate Taught Regulations.

Please ensure that you are aware of the deadlines set by your department(s) and the requirements to meet this deadline, e.g. whether you need to submit electronic and/ or paper copies for your submission to be deemed complete (see 8.16 above).

Section 13 (5)

'In the absence of acceptable extenuating cause, late submission of work will be penalised as follows:

- *for work submitted up to 24 hours late, the mark will be reduced by ten percentage marks; **

- *for work submitted more than 24 hours late, the mark will be zero.'*

*eg. an awarded mark of 65% would be reduced to 55% and a mark of 42% would be reduced to 32%.

If you have had extenuating circumstances, which have affected your ability to submit work by the deadline these should be submitted in writing, accompanied by any relevant documentary evidence, to your department(s). As with all extenuating circumstances it is the discretion of the examiners whether to accept these as a reason for having not submitted work on time. Please see the section for details on **submitting requests for extenuating circumstances** to be considered.

9.4 Stepped Marking

From September 2018, work submitted for assessment will be graded by using a set of marks with the pattern X2, X5 or X8. This means that a merit piece of work would be awarded 62%, 65% or 68%. This approach, which is called stepped marking, has been found to help in better aligning grades with marking criteria and for providing greater clarity to students about the standard of their work and how close they are to lower and upper grade boundaries. For example a 62% represents a low merit, while a 68% indicates a high merit.

Assessed work which is quantitative (e.g. numerical or multiple-choice tests), where there are 'right or wrong' answers, e.g. language tests/ exercises and/ or where there is a detailed mark scheme under which each question is allocated a specific number of marks will be exempt from stepped marking.

9.5 Policy on the return of marked student work and feedback

The full policy on the return of marked student work and feedback is available here.

Return of marked student work and feedback

All assessed work (other than formal examinations) should be returned with feedback within 20 working days of the submission deadline, except in cases where it is not appropriate to do so for exceptional and/ or pedagogic reasons. These may include the assessment of dissertations, final year projects, taped case studies, audio visual submissions, where the marking has been delayed due to staff illness and/ or where an extension to the submission deadline has been granted. The deadline for the return of the marked work with feedback will be made clear to students when they receive their assignments. In the event that the intended deadline cannot be met for reasons such as those listed, the revised deadline will be communicated to students as soon as possible.

9.6 Progression and award requirements

The Regulations governing progression and award requirements are set out in your Programme Specification Programme Specification Repository (and also more generally in the Postgraduate Taught Regulations).

Resits/ repeats

If you do not pass a course unit at a first attempt you may be given an opportunity to resit or repeat the course unit (Section 12 Postgraduate Taught Regulations). Please bear in mind that decisions on which course units you may be permitted to resit or repeat and when (summer or following academic year) will be made by the Sub-board of examiners in line with the provisions of the Postgraduate Taught Regulations.

Resit/Repeat	Clarification
Resit of a failed course unit	The opportunity to resit a failed course unit will either be over the Summer (August) or in the following academic year/ session, depending upon the nature of the assessment and your department's policy in terms of summer resits. Where summer resits are permitted by your department, this will normally be in course units to a maximum of 40 credits. If you are given a resit in a course unit you do not have to attend any further classes. Marks for work which has been passed will be carried forward. The mark for a course unit being resat will normally be capped at 50%. Please note that you are required to register to resit course units.
Repeat of a failed course unit	If you are given the opportunity to repeat a course unit in attendance you will need to register for the course unit for the following academic year and satisfy afresh all the assessment and attendance requirements; that is, you are expected to attend all classes and redo all required coursework and examinations for the course unit. No marks from the previous attempt at the course unit are carried forward and no work completed as part of the first attempt at the course may be resubmitted for assessment. The mark for a course unit repeated in attendance is not capped at 50%. If you are repeating in attendance you can substitute a new course unit for the one failed. The new course unit counts as a second attempt at the unit

Unless you have extenuating circumstances you are only permitted two opportunities to pass a course unit in line with Section 12 (2) of the Postgraduate Taught Regulations

9.7   Examination results

Please see the Examinations & Assessments website for details of how you will be issued with your results.

The Examinations & Assessments website is the place where you can access the "Instructions to Candidates" and details of the examinations appeals procedures.

9.8 Penalties for late submission of work

Work submitted after the published deadline will be penalised in line with Section 13, paragraph (5) of the College's Postgraduate Taught Regulations.

Please ensure that you are aware of the deadlines set by your department(s) and also the requirements to meet this deadline, e.g. whether you need to submit electronic and/ or paper copies for your submission to be deemed complete.

Section 13 (5)

'*In the absence of acceptable extenuating cause, late submission of work will be penalised as follows:*

- *for work submitted up to 24 hours late, the mark will be reduced by ten percentage marks;*
- *for work submitted more than 24 hours late, the mark will be zero.'*

If you believe that you will be unable to submit coursework on time because of illness or other acceptable causes then you should apply for an extension to allow you to submit the work late without suffering a penalty. If you did not request an extension but then miss a deadline due to factors which have affected your ability to submit work on time, then you may submit a request for extenuating circumstances to be considered. Please note however that if you do so, you will have to provide convincing reasons why you had been unable to request an extension.

9.9 Penalties for over-length work

Work which is longer than the stipulated length in the assessment brief will be penalised in line with Section 13 (6) of the College's Postgraduate Taught Regulations.

Section 13 (6)

Any work (written, oral presentation, film, performance) which exceeds the upper limit set will be penalised as follows

(a) *for work which exceeds the upper limit by up to and including 10%, the mark will be reduced by ten percent of the mark initially awarded;*

(b) *for work which exceeds the upper limit by more than 10% and up to and including 20%, the mark will be reduced by twenty percent of the mark initially awarded;*

(c) *for work which exceeds the upper limit by more than 20%, the mark will be reduced by thirty percent of the mark initially awarded.*

The upper limit may be a word limit in the case of written work or a time limit in the case of assessments such as oral work, presentations or films.

In addition to the text, the word count should include quotations and footnotes. Please note that the following are excluded from the word count: candidate number, title, course title, preliminary pages, bibliography and appendices.

9.10 What to do if things go wrong – Extensions to deadlines

You are expected to manage your time appropriately and hand in your coursework assessments on time. However, unforeseeable or unpreventable circumstances may occasionally arise which prevent you from doing so. In this case you should apply for a deadline extension using the College's online extension application system. You can read the policy and guidance on extensions on the College's webpage about Applying for an Extension.

Not every assessment is eligible for an extension via the online system. Listed below are those assessments that are not covered. If you would like an extension for one of these, you should speak directly with staff in your departmental Administrative Office.

The following assessments are not eligible for an extension via the online system:

- Weekly homework submissions.

9.11 What to do if things go wrong – the "Extenuating Circumstances" process.

If you are unable to submit coursework because of unforeseeable or unpreventable circumstances then you should normally apply for an extension (see above) to allow you to submit the work late without suffering a penalty. If this proves impossible then you may apply for extenuating circumstances, which will be considered by the department after the main exam period in May.

Extenuating circumstances are defined as unforeseen *circumstances which are **outside a student's control** and which may **temporarily** prevent a student from undertaking an assessment or have a **marked/ significant detrimental/adverse impact** on their ability to undertake assessment by coursework or examination to the standard normally expected.* You can read more about them here.

This means that such circumstances rarely occur. They are outside your control if they are:

- Unforeseeable - you would not have prior knowledge of the event (e.g. you cannot foresee whether you will be involved in a car accident);
- Unpreventable – you could not reasonably do anything in your power to prevent such an event (e.g. you cannot reasonably prevent a burst appendix.)

It is these short-term (temporary) circumstances that the College normally regards as extenuating circumstances. The policy is explained in full in the Extenuating circumstances – Guidance for students.

Absence from an examination

Section 5 above explains what to do on the day you miss an examination. You should apply for extenuating circumstances if you miss an examination through unexpected illness or other acceptable cause; if you begin an examination and have to leave due to acute illness; or if you believe your performance on the day was seriously compromised by an unexpected and acute illness that you could not reasonably have been expected to have managed otherwise.

Applying for extenuating circumstances

If you apply for extenuating circumstances, you will need to supply a full explanation of your situation together with any supporting documentation. Before going ahead, you should check that your circumstances meet the criteria. These are explained in full in the Extenuating circumstances – Guidance for students. You should also read the section **Illness & absences from an examination and departmental assessments and extenuating circumstances** in the Instructions to Candidates issued by Student Administration.

Ongoing circumstances

If you have ongoing circumstances that you believe are adversely affecting your performance during the year, these should be raised with your department and with the College's Student Advisory & Wellbeing teams as soon as possible. This will allow us to consider strategies that will help you manage the situation. Examples might be that you have an illness that does not constitute a disability, a close family member is ill and needs your support, or you have suffered an adverse life event.

It may be that the circumstances are severely affecting your ability to study by causing you to repeatedly miss scheduled teaching and/ or affecting your ability to complete assessments. If this is the case and there is no reasonable way to help you to manage the situation, then you may need to consider, in consultation with your department and Student Advisory & Wellbeing , if it would be in your best interests to interrupt until the issues have been resolved and you are able to fully commit to and benefit from your academic studies.

Ongoing adverse circumstances do not normally constitute extenuating circumstances as they are not unforeseen and in some cases may be preventable. As such, it is unlikely that the Sub-board will be able to take action to mitigate such circumstances. For further information, please read the Extenuating circumstances – Guidance for students.

9.12 Support and exam access arrangements for students requiring support

Some students at the College may have a physical or mental impairment, chronic medical condition or a Specific Learning Difficulty (SpLD) which would count as a disability as defined by the Equality Act (2010) that is, "a physical or mental impairment which has a long-term and substantial effect on your ability to carry out normal day-to-day activities". It is for such conditions and SpLDs that Disability and Dyslexia Services can put in place adjustments, support and exam access arrangements. Please note that a "long-term" impairment is one that has lasted or is likely to last for 12 months or more.

If you have a disability or SpLD you must register with the Disability and Dyslexia Services Office for an assessment of your needs before adjustments, support and exam access arrangements (') can be put in place. There is a process to apply for special arrangements for your examinations – these are not automatically put in place. Disability and Dyslexia Services can discuss this process with you when you register with them. Please see section 2 above for further guidance about registering with the Disability and Dyslexia Services Office.

Please note that if reasonable adjustments, including exam access arrangements, have been put in place for you during the academic year, the Sub-board will not make further allowance in relation to your disability or SpLD.

9.13 What to do if you have difficulty writing legibly

It is College policy not to mark scripts which are illegible. If you anticipate that you may have difficulty in writing by hand which would lead to your scripts being illegible you should contact Disability and Dyslexia Services. Please note the deadline for making an application for Examination Access Arrangements is in January each year. Therefore it is in your interest to contact DDS as soon as you are able in the Autumn Term in order that you have time to get any necessary evidence required for the application.

9.14 Academic Misconduct

The College regulations on academic misconduct (also known as assessment offences) can found on the Attendance and Academic Regulations page of the student intranet.

Academic misconduct includes, but is not limited to plagiarism (see obelow), commissioning, duplication of work, (that is, submitting work for assessment which has already been submitted for assessment for the same or another course), falsification, impersonation, deception, collusion, (for example, group working would constitute collusion where the discipline or the method of assessment emphasises independent study and collective ideas are presented as uniquely those of the individual submitting the work), failure to comply with the rules governing assessment, including those set out in the 'Instructions to candidates'.

The Regulations set out some of the types of academic misconduct in more detail, the procedures for investigation into allegations of such offences and the penalties. Students are strongly encouraged to read these Regulations and to speak with their Personal Tutors or other members of staff in their department should they have any queries about what constitutes academic misconduct. The College treats academic misconduct very seriously and misunderstanding about what constitutes academic misconduct will not be accepted as an excuse. Similarly, extenuating circumstances cannot excuse academic misconduct.

What is Plagiarism?

'Plagiarism' means the presentation of another person's 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. Plagiarism may occur in any piece of work presented by a student, including examination scripts, although standards for citation of sources may vary dependent on the method of assessment.

Identifying plagiarism is a matter of expert academic judgement, based on a comparison across the student's work and on knowledge of sources, practices and expectations for professional conduct in the discipline. Therefore it is possible to determine that an offence has occurred from an assessment of the student's work alone, without reference to further evidence.

10   Careers information

The College's Careers & Employability Service is based in the Davison Building. The careers service run a number of industry themed weeks and a range of standalone events during the academic year including a careers fair in October. Our events are open to all students. One to one appointments are available all through the year where you can talk over your career ideas or get your CV, cover letter or application checked. You can also book a practice, in person or video interview.

Our website and Careers Moodle has a wide range of help and information including interview skills, writing CVs and applications, assessment centres & psychometric tests.
For more information about all Careers events and appointments visit their website or come along and speak to their friendly and helpful staff.

11   Complaints and academic appeals procedure

If you have a complaint relating to any aspect of the Department or its staff or to any academic or College matter, you should first discuss it informally with your Personal Tutor or with another member of staff in the Department. We would hope that the majority of issues of this kind can be resolved by informal discussion. There are, however, procedures that can be invoked in serious cases. These are set out in the College Complaints Procedures for students. You should raise your complaint **as soon as possible**.

If the complaint concerns an academic decision, there is an academic appeals process. Please note that an academic appeal can only be submitted once you have received your results via the College portal. Details of the appeals procedure and permitted grounds for appeal can be found on the Academic Appeals webpage.

12   Health and Safety Information

The Health and Safety webpage provides general information about our health and safety policies.

12.1   Code of practice on harassment for students

The College is committed to upholding the dignity of the individual and recognises that harassment can be a source of great stress to an individual. Personal harassment can seriously harm working, learning and social conditions and will be regarded and treated seriously. This could include grounds for disciplinary action, and possibly the termination of registration as a student.

The College's Code of Practice on personal harassment for students should be read in conjunction with the Student Disciplinary regulations and the Complaints procedure.

12.2   Lone working policy and procedures

The College has a 'Lone Working Policy and Procedure' that can be found here.

Lone working is defined as working during either normal working hours at an isolated location within the normal workplace or when working outside of normal hours. The Department and the type of work conducted by students is classified as a low risk activity and as such the following advice is relevant.

Any health and safety concerns should be brought to the attention of the Departmental Health and Safety Coordinator or the College Health and Safety Office.

It is likely that most activities will take place on College premises. However, the principles contained in the above section will apply to students undertaking duties off campus.

13   Equal Opportunities Statement and College Codes of Practice

13.1   Equal opportunities statement

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, have equality of opportunity and do not suffer disadvantage on the basis of 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.

13.2   Additional codes of practice

Royal Holloway is committed to upholding the dignity of the individual. Personal harassment can seriously harm working, learning and social conditions at the College. Harassment will be regarded seriously and could be grounds for disciplinary action, which may include termination of registration as a student. Royal Holloway's Code of Practice on Personal Harassment for Students is available at:
https://intranet.royalholloway.ac.uk/ecampus/documents/pdf/codesandregulations/studentharassment.pdf

14   Prizes

14.1 The MSc Achievement Medal

The MSc Achievement Medal is awarded to an MSc student in the Department of Mathematics in recognition of outstanding performance across the taught part of the programme (excluding dissertation).

14.2 The MSc Dissertation Medal

The MSc Dissertation Medal is awarded to an MSc student in the Department of Mathematics in recognition of outstanding performance in their dissertation.

15   Course Specification Forms

The information contained in these course outlines below is correct at the time of publication, but may be subject to change as part of the Department's policy of continuous improvement and development. Every effort will be made to notify you of any such changes.

COMPUTATIONAL NUMBER THEORY

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Computational Number Theory	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5412	**Course JACS Code:** (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	**Status:**	Optional Condonable
Pre-requisites:	UG course in number theory	**Co-requisites:**	-
Aims:	To provide an introduction to many major methods currently used for testing/proving primality and for the factorisation of composite integers. The course will develop the mathematical theory that underlies these methods, as well as describing the methods themselves.		
Learning Outcomes:	1. Be familiar with a variety of methods used for testing/proving primality, and for the factorisation of composite integers. 2. Have an introductory knowledge of the theory of binary quadratic forms, elliptic curves, and quadratic number fields, sufficient to understand the principles behind state-of-the art factorisation methods. 3. Be equipped with the tools to analyse the complexity of some fundamental number-theoretic algorithms. 4. Demonstrate independent learning skills		
Course Content:	Background: Complexity analysis; revision of Euclid's algorithm, and continued fractions; the Prime Number Theorem; smooth numbers; elliptic curves over a finite prime field; square roots modulo a prime; quadratic number fields; binary quadratic forms; fast polynomial evaluation. Primality tests: Fermat test; Carmichael numbers; Euler test; Euler-Jacobi test; Miller-Rabin test; Lucas test; AKS test. Primality proofs: succinct certificates; $p - 1$ methods; elliptic curve method; AKS method.Factorisation: Trial division; Fermat's method, and extensions; methods using binary quadratic forms; Pollard's $p - 1$ method; elliptic curve method; Pollard's rho and roo methods; factor-base methods; quadratic sieve; number field sieve.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures over 11 weeks. 33 hours in total. 167 hours of private study, including work on the miniproject, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Prime Numbers: a Computational Perspective – R. Crandall and C. Pomerance (Springer 2005). 512.91 CRA A course in number theory and cryptography – N Koblitz (Springer 1994). 512.91 KOB. A course in number theory – H.E. Rose (Oxford, 1994)		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** Written exam 90%. Two hour paper. **Coursework:** 10% Individual unsupervised mini-project.		

Principles of Algorithm Design

Department/School:	Mathematics	Academic Session:	2015-16
Course Title:	Principles of Algorithm Design	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5414	**Course JACS Code:** (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	**Status:**	Optional Condonable
Pre-requisites:	An undergraduate course in discrete mathematics	**Co-requisites:**	-
Co-ordinator:	-		
Course Staff:	-		
Aims:	Key aims of the course include: _ to provide an introduction to the theory of algorithms; _ to develop the skill of designing algorithms. Basic algorithmic principles: Greedy algorithms, divide-and-conquer, dynamic programming, randomized algorithms. Analysis of algorithms: Recurrences, O-notation, worst-case analysis, amortized analysis, probabilistic analysis; lower bounds for comparison-based sorting and finding the median. Basic data structures: arrays, stacks, balanced search trees, hashing.		
Learning Outcomes:	1. understand and apply the fundamental principles of algorithm design; 2. analyse basic algorithms; know amortized, average-case and worst-case analysis; 3. know basic data-structures 4. know efficient algorithms for sorting numbers; know lower bounds on comparison based algorithms for sorting numbers; 5. know asymptotic notation. 6. Demonstrate independent learning skills		
Course Content:	The development of efficient algorithms is essential when considering problems with large inputs. Usually an algorithm has certain specifications, for example that it should solve a problem and take at most f(n) steps on any input of size n. This course is about the design of efficient algorithms and proving that they meet the desired specification. The course introduces basic principles and methods of algorithm design and analysis and considers fundamental problems like sorting numbers and multiplying matrices.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures over 11 weeks. Total 33 hours. 167 hours of private study, including work on the mini-project, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Introduction to Algorithms by Cormen, Leiserson, Rivest, and Stein Probability and Computing: Randomized Algorithms and Probabilistic Analysis by Mitzenmacher and Upfal.		
Formative Assessment & Feedback:	Formative assessment in form of 8 problem sheets. The student will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Written exam. **Coursework:** 10% Individual unsupervised mini-project.		

Updated Sep 15

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INFERENCE

Department/School:	**Mathematics**	Academic Session:	**2018-19**
Course Title:	Inference	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	200 hr
Course Code:	MT5432	**Course JACS Code:** (Please contact Data Management for advice)	G350
Availability: (Please state which teaching terms)	Term 1	**Status:**	Optional Condonable
Pre-requisites:	-	**Co-requisites:**	-
Aims:	This is a graduate level course intended to provide the mathematical theory underlying the main principles and methods of statistics, in particular, to introduce the mathematical theory of parametric estimation and hypotheses testing.		
Learning Outcomes:	On completion of the course, students should be able to demonstrate a deep understanding of some of the advanced concepts and results of the theory of estimation and hypothesis testing with main emphasis on the general methodology rather than special models occurring in applications; formulate statistical problems in rigorous mathematical terms; select and apply appropriate tools of mathematical statistics and advanced probability to analyse and solve the problems; understand and construct mathematical proofs of some of the main theoretical results of mathematical statistics; understand the concepts and results in asymptotic theory of estimation.		
Course Content:	Estimation: Exponential Family. Maximum likelihood method. Method of moments. Sufficiency Principle. Factorization criterion. Lehmann-Scheffe criterion. Completeness theorem in exponential family. Rao-Blackwell Theorem. Cramer-Rao inequality and efficiency. Best unbiased estimators. Hypothesis testing: Neyman-Pearson framework. Uniformly most powerful tests. Unbiasedness. Likelihood ratio tests. Asymptotic evaluations: Consistency. Asymptotic normality. Asymptotic properties of maximum likelihood estimators. Asymptotic relative efficiency. Robustness. M-estimators.		
Teaching & Learning Methods:	44 hours of lectures and examples classes. 156 hours of private study, including work on problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Statistical Inference – G Casella and R L Berger (Duxbury 2001) Library reference 518.1 CAS		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 100% Written exam. Two hours. **Coursework:**		

APPLIED PROBILITY

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Applied Probability	Course Value: (UG courses = unit value, PG courses = notional learning hours)	200 hr
Course Code:	MT5436	Course JACS Code: (Please contact Data Management for advice)	G330
Availability: (Please state which teaching terms)	Term 2	Status:	Optional
Pre-requisites:	-	Co-requisites:	-
Aims:	This is a graduate level course intended familiarise students with the principal methods of the theory of stochastic processes and to introduce a range of examples of probabilistic methods used to model systems that exhibit random behaviour.		
Learning Outcomes:	On completion of the course the student should be able to: use the method of conditioning and the method of conditional expectation; use the method of generating functions; understand the structure and concepts of discrete and continuous time Markov chain with countable state space; construct a probability model for a variety of problems; understand the structure of diffusion processes; understand the concept of Brownian motion.		
Course Content:	Preliminaries: Conditional expectation; generating functions; Distribution of random sums; Stochastic processes - basic Notions. Poisson Process: Inter-arrival and waiting times; Conditional distribution of the waiting times; Nonhomogeneous processes; Compound Poisson process. Renewal theory: Renewal processes; Some limit theorems; Alternating renewal processes; Delayed renewal processes; Cumulative renewal processes. Markov processes: Markov chains, classification of states, Some limit theorems; Stationary distributions; Absorption probabilities. Diffusion Processes: Forward and backward diffusion equations; Brownian motion, Wiener processes, Ito's Formula.		
Teaching & Learning Methods:	44 hours of lectures and examples classes. 156 hours of private study, including work on problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Probability and Random Processes – G R Grimmett and D R Stirzaker (Oxford UP 1992). Library Ref. 518.1 GRI Stochastic Processes – S M Ross (Wiley 1996) Library Ref. 519.2 Introduction to Probability Models – S M Ross (Academic Press 2003). Library Ref. 518.1 ROS		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** Written exam 100% Two hour exam. **Coursework:**		

CHANNELS

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Channels	Course Value: (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5441	Course JACS Code: (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 1	Status:	Mandatory for MCC Optional for MfA Condonable
Pre-requisites:	Undergraduate courses in probability and algebra.	Co-requisites:	-
Aims:	To investigate the problems of data compression and information transmission in both noiseless and noisy environments.		
Learning Outcomes:	1. state and derive a range of information-theoretic equalities and inequalities; 2. explain data-compression techniques for ergodic as well as memoryless sources; 3. explain the asymptotic equipartition property of ergodic sources; 4. understand the proof of the noiseless coding theorem; define and use the concept of channel capacity of a noisy channel; explain the noisy channel coding theorem; 5. understand a range of further applications of the theory. 6. Demonstrate independent learning skills		
Course Content:	Entropy: Definition and mathematical properties of entropy, information and mutual information. Noiseless coding: Memoryless sources: proof of the Kraft inequality for uniquely decipherable codes, proof of the optimality of Huffman codes, typical sequences of a memoryless source, the fixed-length coding theorem. Ergodic sources: entropy rate, the asymptotic equipartition property, the noiseless coding theorem for ergodic sources. Lempel-Ziv coding. Noisy coding: Noisy channels, the noisy channel coding theory, channel capacity. Further topics, such as hash codes, or the information-theoretic approach to cryptography and authentication.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. 33 hours in total. 167 hours of private study, including work on the mini-project, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Codes and Cryptography – D Welsh (Oxford UP 1988), Library reference 001.5436 WEL Elements of Information Theory – T M Cover and J A Thomas (Wiley 1991), Library Reference 001.539 COV Information Theory, Inference, and Learning Algorithms – D J C MacKay (Cambridge UP 2003), Library Reference 001.539 MAC		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Written Exam. Two hour written exam. **Coursework: 10%** Individual unsupervised mini-project		

Quantum Information Theory

DEPARTMENT OF MATHEMATICS			Academic Session 2018-19	
Course Code:	MT5445	**Course Value:**	200 hours	**Status:** *(ie:Core, or Optional)*	Optional
Course Title:	Quantum Information Theory		**Availability:** *(state which teaching terms)*	Term 2
Prerequisites:	Undergraduate courses in probability and linear algebra.		**Recommended:**	None
Aims:	'Anybody who is not shocked by quantum theory has not understood it' (Niels Bohr). This course aims to provide a sufficient understanding of quantum theory in the spirit of the above quote. Many applications of the novel field of quantum information theory can be studied using undergraduate mathematics.			
Learning Outcomes:	On completion of the course the student should be able to: • demonstrate a comprehensive understanding of the principles of quantum superposition and quantum measurement; • use the basic linear algebra tools of quantum information theory confidently; • manipulate tensor-product states and use and explain the concept of entanglement; • explain applications of entanglement such as quantum teleportation or quantum secret key distribution; • describe the Einstein-Podolsky-Rosen paradox and derive a Bell inequality; • solve a range of problems involving one or two quantum bits; • discuss Deutsch's algorithm and its implications for the power of a quantum computer; • understand and apply Grover's search algorithm.			
Course Content:	**Linear algebra:** Complex vector space, inner product, Dirac notation, projection operators, unitary operators, Hermitian operators, Pauli matrices. **One qubit:** Pure states of a qubit, the Poincaré sphere, von Neumann measurements, quantum logic gates for a single qubit. **Tensor products:** 2 qubits, 3 qubits, quantum logic gates for 2 qubits, Deutsch's algorithm, the Schmidt decomposition. **Mixed states:** Partial trace, probability, entropy, von Neumann entropy. **Entanglement:** The Einstein-Podolsky-Rosen paradox, Bell inequalities, quantum teleportation, measures of entanglement, decoherence. **Grover's search algorithm**, and applications. **Further applications,** such as e.g. the quantum Fourier transform, Shor's factoring algorithm, the BB84 key distribution protocol, quantum channel capacity, the Holevo bound.			
Teaching & Learning Methods:	33 hours of lectures and examples classes. 167 hours of private study, including work on problem sheets, the self-study module on Grover's algorithm, and examination preparation. This may include discussions with the course leader if the student wishes.			
Key Bibliography:	M A Nielsen and I L Chuang – Quantum Computation and Quantum Information (Cambridge 2000). *Library Ref. 001.64 NIE*			
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.			
Summative Assessment:	**Exam:** Written exam 100% Two hour exam.			

ADVANCED FINANCIAL MATHEMATICS

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Advanced Financial Mathematics	Course Value: (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5448	Course JACS Code: (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	Status:	Optional Condonable
Pre-requisites:	An undergraduate course in financial mathematics	Co-requisites:	-
Aims:	To investigate the validity of various linear and non-linear time series occurring in finance; To extend the use of stochastic calculus to interest rate movements and credit rating;		
Learning Outcomes:	1. make use of some of the ARCH (autoregressive conditionally heteroscedastic) family of models in time series; 2. appreciate the ideas behind the use of the BDS test and the bispectral test for time series. 3. understand the partial differential equation for interest rates and the assumptions that lead to it; 4. be able to model forward and spot rates; 5. see how to model the prices for certain exotic options. 6. Demonstrate independent learning skills		
Course Content:	Financial time series: Linear time series: ARMA and ARIMA models, stationarity, Auto-regressions. Testing of linearity, using spectral analysis. ARCH and GARCH models. Structure of financial series: The random walk model, trend and volatility, moments. Comparison with chaotic systems, dimensionality and memory effects in financial series. The nearest neighbour algorithm and the BDS test. Interest rate analysis: Revision of ideas in stochastic calculus. Modelling of interest rates, the bond pricing equation. Bond derivatives. The Heath-Jarrow-Morton model. Exotic options: Asian and barrier options.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. 33 hours total. 167 hours of private study, including work on the miniproject, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Paul Wilmott Introduces Quantitative Finance – P Wilmott (Wiley 2007) Library reference 332.632 WIL Analysis of Financial Time Series – R S Tsay (Wiley 2005) Library reference 330.0151 TSA		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** Written exam 90%. Two hour paper. **Coursework:** 10% Individual unsupervised mini-project.		

COMBINATORICS

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Combinatorics	Course Value: (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5454	Course JACS Code: (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 1	Status:	Optional Condonable
Pre-requisites:	An undergraduate course in discrete mathematics	Co-requisites:	-
Aims:	To introduce some standard techniques and concepts of combinatorics, including methods of counting including the principle of inclusion and exclusion; generating functions; probabilistic methods; permutations, Ramsey theory.		
Learning Outcomes:	1. Perform simple calculations with generating functions;. 2. Understand Ramsey numbers and calculate upper and lower bounds for these (where practical); 3. Calculate sets by inclusion and exclusion and understand the applications to number theory; 4. Use simple probabilistic tools for solving combinatorial problems. 5. Demonstrate independent learning skills		
Course Content:	Enumeration: Binomial identities. The Principle of Inclusion-Exclusion with applications to number theory. Rook polynomials. Generating functions: Linear recursion. Power series and ordinary generating functions. Singularities. Ramsey Theory: Monochromatic subsets, Ramsey numbers and Ramsey's Theorem. Probabilistic methods: First-moment method, Lovász local lemma.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. Total 33 hours. 167 hours of private study, including work on the mini-project, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Discrete Mathematics −□N L Biggs (Oxford UP) 510 BIG. Combinatorics: Topics, Techniques, Algorithms – P J Cameron (Cambridge UP) 512.23 CAM. Invitation to Discrete Mathematics = J Matoušek and J Nešetřil (Oxford UP) 512.23 MAT		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Two hour written exam. **Coursework:** 10% unsupervised miniproject		

THEORY OF ERROR-CORRECTING CODES

Department/School:	Mathematics		Academic Session:	2018-19
Course Title:	Theory of Error-Correcting Codes		**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5461		**Course JACS Code:** (Please contact Data Management for advice)	
Availability: (Please state which teaching terms)	Term 2		**Status:**	Mandatory for MCC MSc
Pre-requisites:	Undergraduate courses on linear algebra and finite fields		**Co-requisites:**	-
Aims:	To provide an introduction to the theory of error-correcting codes employing the methods of elementary enumeration, linear algebra and finite fields.			
Learning Outcomes:	On completion of the course, students should: • calculate the probability of error or the necessity of retransmission for a binary symmetric channel with given cross-over probability, with and without coding; • prove and apply various bounds on the number of possible code words in a code of given length and minimal distance; • use MOLSs and Hadamard matrices to construct medium-sized linear codes of certain parameters; • reduce a linear code to standard form, finding a parity check matrix, building standard array and syndrome decoding tables, including for partial decoding; • know/prove/apply the theorem that a cyclic code of length n over a field consists of the codewords corresponding to all multiples of any factor of x^n-1; • understand the structure of BCH codes.			
Course Content:	**Basic theory of coding:** Words, codes, errors, t-error detection and t-error correction. The Hamming distance in the space $V(n,q)$ of n-tuples over an alphabet of q symbols (with emphasis on $(Z_2)^n$). Probability calculations. **The main coding theory problem:** Construction of small binary codes. Rate of a code. Equivalence of codes. The Hamming, Singleton, Gilbert-Varshamov and Plotkin bounds. Puncturing a code. Perfect codes. Hadamard codes and Levenshtein's Theorem. Codes based on mutually orthogonal latin squares (MOLS). **Linear codes:** Linear codes as linear subspaces of $V(n,q)$. Generator and parity check matrices, standard array and syndrome decoding. Dual of a code. Hamming codes. **Cyclic codes:** Structure of $GF(q)$ relevant to coding theory, minimal polynomial of an element of $GF(q)$; generator polynomial, check polynomial; BCH codes, RS codes.			
Teaching & Learning Methods:	44 hours of lectures and examples classes. 156 hours of private study, including work on problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.			
Key Bibliography:	A First Course in Coding Theory – R Hill (Oxford UP) *001.539 HIL* Coding Theory – a First Course – S Ling and C Xing (Cambridge UP) *001.539 LIN* The Theory of Error-Correcting Codes – F J MacWilliams and N J A Sloane (North-Holland) *512.23 MAC*			
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.			
Summative Assessment:	**Exam:** Two hour written exam. 100% **Coursework:**			

ADVANCED CIPHER SYSTEMS

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Advanced Cipher Systems	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	200 hr
Course Code:	MT5462	**Course JACS Code:** (Please contact Data Management for advice)	
Availability: (Please state which teaching terms)	Term 1	**Status:**	Mandatory for MCC MSc
Pre-requisites:	UG courses in linear algebra and probability	**Co-requisites:**	-
Aims:	To introduce and study the mathematical and security properties of both symmetric key cipher systems and public key cryptography, covering methods for obtaining confidentiality and authentication.		
Learning Outcomes:	On completion of the course the student should be able to: Understand the concepts of secure communications and cipher systems; Understand and use statistical information and the concept of entropy in the cryptanalysis of cipher systems; Understand the main properties of Boolean functions, and their applications and use in cryptographic algorithms; Understand the structure of stream ciphers and block ciphers; Know how to construct as well as have an appreciation of desirable properties of keystream generators, and understand and manipulate the concept of perfect secrecy; Understand the main mathematical and statistical properties of Feedback Shift Registers, and of FSR-based stream ciphers; Understand the modes of operation of block ciphers and their properties; Understand the main design principles and cryptographic techniques of modern symmetric cryptography algorithms; Understand the concept of public key cryptography, including the details of the RSA and ElGamal cryptosystems, both in the description of the schemes and in their cryptanalysis; Understand the concepts of authentication, identification and signature, be familiar with techniques that provide these, including one-way functions, hash functions and interactive protocols and the Fiat-Shamir scheme; Understand the problems of key management, and be aware of key distribution techniques.		
Course Content:	Cipher systems: An introductory overview of the aims and types of ciphers. Methods and types of attack. Information theory. Boolean functions. Statistical tests. Stream ciphers: The one-time pad. Pseudo-random key streams – properties and generation. Mathematical and statistical properties of feedback shift registers. Berlekamp-Massey algorithm. Design principles and cryptanalytic techniques of modern stream ciphers. Block ciphers: Confusion and diffusion. Iterated block ciphers – substitution/permutation. SP-networks. The Feistel principle. DES, AES. Modes of operation. Linear and differentiable cryptanalysis, and related cryptographic techniques. Public key ciphers: Discussion of key management. Diffie-Hellman key exchange. One-way functions and trapdoors. RSA, ElGamal cryptosystem. Authentication/identification: Protocols. Challenge/response. MACs. Zero-knowledge protocols; Fiat-Shamir protocol. Digital signatures: Digital signature methods. Hash functions – design and analysis techniques. DSS. Digital certificates.		
Teaching & Learning Methods:	44 hours of lectures and examples classes. 156 hours of private study, including work on problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Codes and Cryptography – D Welsh (Oxford 1988) 001.5436 WEL Cipher Systems – H J Beker and F C Piper (Van Nostrand 1982) 001.5436 BEK		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** Two hour written exam: 100%		

PUBLIC KEY CRYPTOGRAPHY

Department/School:	**Mathematics**	Academic Session:	**20118-19**
Course Title:	Public Key Cryptography	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5466	**Course JACS Code:** (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	**Status:**	Optional for MfA Mandatory for MCC Condonable
Pre-requisites:	MT5462	**Co-requisites:**	
Aims:	To introduce some of the mathematical ideas essential for an understanding of public key cryptography, such as discrete logarithms, lattices and elliptic curves; To introduce several important public key cryptosystems, such as RSA, Rabin, ElGamal Encryption, Schnorr signatures; To discuss modern notions of security and attack models for public key cryptosystems.		
Learning Outcomes:	1. be familiar with the RSA and Rabin cryptosystems, the hard problems on which their security relies and certain attacks on them; 2. have a basic knowledge of finite fields and elliptic curves over finite fields, and the discrete logarithm problem in these groups; be familiar with cryptosystems based on discrete logarithms, and some algorithms for solving the discrete logarithm problem; 3. know the definition of a lattice and be familiar with the LLL algorithm and some applications of lattices in cryptography and cryptanalysis; 4. be able to define security notions and attack models relevant for modern theoretical cryptography, such as indistinguishability and adaptive chosen ciphertext attack.; be able to critically analyse cryptosystems;		
Course Content:	Background: Integers modulon; Chinese remainder theorem; finite fields; fast exponentiation; public key cryptography and security; complexity theory. RSA/Rabin: Key generation; implementation; encryption and signatures; OAEP; the RSA problem and relationship with factoring; square roots modulo a prime; Hastad attack; Wiener attack. Discrete logarithms: Diffie-Hellman; ElGamal encryption; Schnorr signatures; Diffie-Hellman problem and decision Diffie-Hellman; methods to solve discrete logarithms such as baby-step-giant-step, Pollard rho and lambda, index calculus. Lattices: Definition of a lattice; GGH cryptosystem; LLL algorithm; lattice attacks on knapsack cryptosystems and variants of RSA. Elliptic curves: Group law; Hasse bound; group structure; point counting; ECC protocols; Maurer equivalence of DH and DL.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. Total 33 hours. 167 hours of private study, including work on the miniproject, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Cryptography: an introduction – Nigel Smart (McGraw Hill) 001.5436 SMA Cryptography theory and practice – Doug Stinson (CRC press, 2nd ed.) 001.5436 STI		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Two hour written exam. **Coursework:** 10% unsupervised mini-project.		

APPLICATIONS OF FIELD THEORY

Department/School:	Mathematics	Academic Session:	2018-19
Course Title:	Applications of Field Theory	Course Value: (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5485	Course JACS Code: (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 1	Status:	Optional Condonable
Pre-requisites:	An undergraduate course covering the elementary theory of groups, rings and fields.	Co-requisites:	-
Aims:	To introduce some of the basic theory of field extensions, with special emphasis on applications in the context of finite fields.		
Learning Outcomes:	1. understand simple field extensions of finite degree; 2. classify finite fields and determine the number of irreducible polynomials over a finite field; 3. state the fundamental theorem of Galois theory; 4. compute in a finite field; 5. understand some of the applications of fields. 6. Demonstrate independent learning skills		
Course Content:	Extension theory: Polynomial factorisation. Field extensions. Simple extensions. The degree of an extension. Applications to ruler and compass constructions. Classifying finite fields: The number of irreducible polynomials. Existence and uniqueness of finite fields of a given size. Concrete representations of a finite field. The structure of finite fields: Roots of irreducible polynomials and the Frobenius automorphism. Cyclotomic polynomials. The Galois correspondence for finite fields. An indication of Galois correspondence for general fields. The norm and trace of an element. Applications to m-sequences. Dual and self-dual bases. Normal bases and the normal basis theorem. Applications to multiplication in finite fields. Discrete logarithms: The discrete log problem and its applications. The Pohlig-Hellman and baby step, giant step algorithms.		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. Total 33 hours. 167 hours of private study, including work on the miniproject, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	Introduction to Finite Fields and their Applications – R. Lidl and H. Niederreiter (Cambridge UP 1994); Library reference 512.4 LID. Galois Theory – I. Stewart (Chapman and Hall 2003); Library reference 512.4 STE.		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Written Exam. Two hour paper. **Coursework:** 10% Individual unsupervised mini-project.		

TOPOLOGY

Department/School:	**Mathematics**	Academic Session:	**2018-19**
Course Title:	Topology	**Course Value:** (UG courses = unit value, PG courses = notional learning hours)	20 credits
Course Code:	MT5491	**Course JACS Code:** (Please contact Data Management for advice)	G100
Availability: (Please state which teaching terms)	Term 2	**Status:** (i.e.: Core, Core PR, Compulsory, Optional)	Optional Condonable
Pre-requisites:	Undergraduate real analysis	**Co-requisites:**	-
Aims:	To introduce students to the basic concepts of metric and topological spaces, and to some aspects of low-dimensional topology.		
Learning Outcomes:	1. Understand what it means for knots and links to be equivalent, understand the concept of a knot invariant, and be able to use some invariants to distinguish knots and links. 2. Understand the defining properties of a metric space, and determine whether a given function defines a metric; understand some basic concepts of metric spaces. 3. Understand the definition of a topological space, and be able to verify the axioms in examples. 4. Understand the concepts of subspace, product spaces, quotient spaces, Hausdorff space, homeomorphism, connectedness and compactness. 5. Understand the notions of Euler characteristic, orientability and apply these to classify closed surfaces. 6. Demonstrate independent learning skills		
Course Content:	Knot theory: knot and link diagrams, the Reidemeister moves, 3-colourings of knot diagrams, n-colourings of knot diagrams. Metric spaces: definition of metric spaces; examples of metric spaces, open and closed sets, further topics may include: compactness, Cantor set, continuous maps. Topological spaces: (motivated by properties of open sets in a metric space), examples of topological spaces, subspaces, connectivity, Hausdorff property, continuous functions, homeomorphisms, paths, path-connectedness, product topology, compactness, quotient spaces. Surfaces: identification spaces, connected sums, orientability, triangulations, Euler characteristic, standard examples including the sphere, the cylinder, the torus, the Möbius band, the projective plane, and the Klein bottle; the classification of surfaces. If time permits one or more of the following topics: homotopy, fixed point theorems, further knot theory		
Teaching & Learning Methods:	The total number of notional learning hours associated with this course are 200. 3 hours of lectures per week over 11 weeks. Total 33 hours. 167 hours of private study, including work on the mini-project, problem sheets and examination preparation. This may include discussions with the course leader if the student wishes.		
Key Bibliography:	M.A. Armstrong, Basic topology. Undergraduate Texts in Mathematics. Springer-Verlag, 1983. S. E. Goodman, Beginning Topology, American Mathematical Society, 2009. J. A. Munkres, Topology, second edition, Pearson, 1999. W. A. Sutherland, Introduction to metric and topological spaces. Second edition Oxford University Press, 2009.		
Formative Assessment & Feedback:	Formative assignments in the form of 8 problem sheets. The students will receive feedback as written comments on their attempts.		
Summative Assessment:	**Exam:** 90% Written Exam. Two hour paper. **Coursework:** 10% Unsupervised miniproject **Deadlines:**		

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