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Introduction
Welcome to Birkbeck. We hope you will enjoy your time here. This handbook aims to provide the information you need to get started here and will be a useful reference throughout your programme. It can also be downloaded from.

We have included information about the modules you will study on your programme, as well as guidance on dealing with coursework and examinations and the ways in which Birkbeck can help with this, such as library and computing facilities and provision for students with a disability.

If you have any questions or difficulties during your time at Birkbeck, there are several people who can help. The administrator for the MSc Mathematics is Cassie Fernandes. She will be your main point of contact for information about the programme. She is available in the Department office between 10am and 6pm weekdays. You can also speak to your personal tutor (you will be told who this is) about your programme or any issues affecting your studies. Lecturers are happy to answer questions about their modules. Contact details for all staff are given at the end of the handbook.

About Birkbeck
Birkbeck College was founded in 1823 and is one of the multi-faculty colleges of the University of London. The principal aim of the College is to provide for part-time students engaged in earning their livelihood during the daytime. The vast majority of Birkbeck students study part-time, and all mathematics and statistics programmes here are designed exclusively for part-time study. Birkbeck has consistently been highly rated both for the quality of its teaching and its research – in fact we have the highest proportion of research-active academic staff of all London Universities. This means our curricula and teaching programmes are kept up-to-date and relevant. We are regularly rated very highly in the annual National Student Survey for the quality of our teaching.

Mathematics and Statistics
The Mathematics and Statistics section is part of the Department of Economics, Mathematics and Statistics in the School of Business, Economics and Informatics. The Department has an excellent teaching record. It has been praised by both internal and external quality assurance reviews for the level of support and guidance available to students, and the constructive admissions procedure, which enables students from a wide variety of backgrounds to gain access to higher education.

Members of Staff
All mathematics and statistics academic staff are involved in teaching as well as active researchers, and we strive to provide a friendly and sympathetic environment for our students. The following academic staff are involved in the MSc Mathematics. Contact details for staff can be found in the section at the end of this handbook.

- Andrew Bowler, BSc (Warwick), MSc (Nottingham), PhD (London) Lecturer in Mathematics, BSc Mathematics Programme Director
- Brad Baxter, MA (Cantab), MMath (Cantab), PhD (Cantab), Reader in Mathematics
- Ben Fairbairn, MMath MA (Cantab), PhD (Birmingham), Senior Lecturer in Mathematics, Undergraduate Mathematics and Statistics Examinations Officer
- Sarah Hart, MA (Oxon), MSc (Manchester), PhD (UMIST), Professor of Mathematics, Head of Department of Economics, Mathematics and Statistics
- Steven Noble, BA (Oxon), DPhil (Oxon), Reader in Mathematics
- Maura Paterson, BSc (Adelaide), PhD (London), Reader in Mathematics, MSc Mathematics and MSc Mathematics and Financial Modelling Programme Director
What we expect you to know before you start

Students on an MSc in Mathematics are expected to have a good grounding in undergraduate topics. Our MSc focuses on algebra and combinatorics. With that in mind, here is an indicative list of the areas with which it is helpful to be familiar before you start the course. At the end are a couple of suggested books which can help get you up to speed if you feel you might need to revise certain topics.

- **Group Theory**: definition of group and abelian group, common examples, permutations and the groups $S_n$ and $A_n$. Subgroups, cosets, Lagrange's Theorem, normal subgroups, homomorphisms, isomorphisms, quotient groups, conjugacy.
- **Rings and Fields**: definition of a ring and a field, familiarity with examples including the rings of integers and of real polynomials, the fields of real, rational and complex numbers, and finite fields such as the integers modulo a prime $p$. Subrings, zero divisors, units, integral domains, irreducible elements.
- **Linear Algebra**: vector spaces, spanning sets, linear independence, bases, dimension, linear transformations, matrices, eigenvalues and eigenvectors, row/column reduction of matrices, determinants, inverses, orthogonality.
- **Analysis**: sets, functions, differentiation and integration of standard functions, partial derivatives, formal definitions of continuity and differentiability. Sequences, series, convergence, tests for convergence, results such as the Monotone Convergence Theorem and the Intermediate Value Theorem.

**Recommended Books** There are many good texts on undergraduate algebra and analysis. The book *Introduction To Algebra* by Peter Cameron (ISBN 978-019-852793) is an excellent text covering sets, groups, rings, fields and vector spaces, although unusually it covers rings before groups. If you know the material in Chapters 1,2,3,4 and 6, you should be fine for algebra, though *Linear Algebra*, by RBJT Allenby (ISBN 0340 610441) is a gentler introduction to linear algebra, with more examples and exercises. For Analysis, *Guide to Analysis* by Mary Hart (ISBN 0333-794494) covers the basics.

**Communication between Students and the Department**
Apart from face-to-face communication, there are three main ways in which we will give you information.

**Email**
Email will be the main way that we update you about your programme. When you register you will be asked to provide an email address. If you wish, you can be given a Birkbeck email address. You are expected to check your email regularly as this will be the main way that we update you about your programme.

**Online**
There are many resources both on the Department website, the virtual learning environment Moodle (moodle.bbk.ac.uk) and the MyBirkbeck webpage (www.bbk.ac.uk/mybirkbeck/). The MyBirkbeck page has links to the Library, Finance pages, Students’ Union, Disability Office and Careers Service. On the Department mathematics and statistics pages you will find timetables, items of news, minutes of Student-Staff exchange meetings. The Moodle resources for individual modules will vary depending on the lecturer and how long the module has been running. However you will always find a syllabus, learning outcomes and a list of recommended books. Additionally all assignments will be
available to download, as well as being distributed in lectures. To access Moodle you will need your Birkbeck username and password which you will be given when you enrol.

**Noticeboards**

There are noticeboards in the department where programme information is posted. It is worth checking them regularly. Opposite the lifts on the 7th floor, there is a noticeboard with lecture timetables and information about coursework, such as which assignments are ready for collection and confirmation of whose work has been received. Minutes of Student-Staff exchange meetings are posted on the noticeboards opposite room 719 (by the Department Office), along with other information such as job advertisements.

**Student Feedback**

It is essential for the success of the degree programme that we are able to find out what you think of it. It is our policy to seek students' feedback about all the courses and lecturers, and to act upon this information. There are several ways in which you can give us feedback.

**Informal Feedback:** We welcome comments and feedback during courses; if there are any issues then the sooner we know about them the better. The first port of call should be the module lecturer; but if that’s not appropriate you should approach the programme director.

**Student-Staff Exchange Meetings:** These are timetabled twice a year, once in the Autumn Term and once after the Summer exams. All students and staff are invited to give and offer feedback and discuss any issues that have arisen.

**Course Evaluations:** These are handed out at the end of each term and each module for your comments. In these, you are asked to comment on the quality of the teaching for that module. Responses are reviewed at the Department’s Teaching Sub-Committee, and any important responses will be provided to students at the Student-Staff Exchange meetings.

**Personal Tutors**

Every student is assigned a Personal Tutor. Your personal tutor is there to discuss any problems and advise you on your academic progress. If you have any health or other personal issues, or academic problems that are worrying you or that might affect your ability to keep up with your work, you should come and discuss them with your personal tutor at the earliest opportunity. Even if you are not experiencing any difficulties, you should make sure you see your personal tutor at least once a term to let him or her know how you are doing. Most academic staff have weekly ‘office hours’ which are posted on their websites and office doors. At these times you can just drop in without an appointment. Staff are often able to see students at other times too, but it is best to make an appointment by phone or email to ensure that they are available.

**Fees and Financial Support**

Students enrolled at Birkbeck have to pay fees. These cover the cost of tuition, registration and examinations. Detailed information about fees and financial support are available online at [http://www.bbk.ac.uk/mybirkbeck/finance](http://www.bbk.ac.uk/mybirkbeck/finance).

Fees can be paid in a variety of ways, including by monthly direct debit, and you will receive more information about this when you take up your place here. Until you have arranged payment of your fees, you will not be given a student card. This means you will not have access to the library or computing facilities.
Orientation and induction events

To help our new students settle into Birkbeck, we offer orientation and induction events at the beginning of each academic year. If you are starting a course in October, we recommend you come along to September Student Orientation event for all new students.

By attending the event, you will have the opportunity to attend a number of talks on areas such as the library resources, study skills, organising your time and much more. To register for the Birkbeck Orientation event you will need to be enrolled on your course or have received an unconditional offer in order to be able to attend.

You can also contact the MyBirkbeck helpdesk if you need any help booking your place. Additionally there will be a programme specific MSc Maths induction event in the last week of September. We’ll send you more information about this in due course.

Withdrawal from Programme

If for any reason you are considering withdrawing from the programme, please come and discuss this with your personal tutor as soon as possible. It may be possible to take a break in studies rather than withdrawing completely. If you wish to take a break in studies, you need to do this via your My Birkbeck profile, by clicking on the ‘Change’ button. Full details are available at:

A student who withdraws fifteen or more days after the start of the first term of study is liable for payment of tuition fees for the first term of their intended study, and all subsequent terms up to and including the term in which they withdraw. So the fees charged would be as follows.

- Students leaving in the first 14 days of the Autumn Term – administration fee only;
- Students leaving during Autumn term or before the end of the first fortnight of Spring Term – Autumn Term fees only are payable;
- Students leaving during Spring Term or before the end of the first fortnight of Summer Term – Autumn and Spring Terms fees only are payable;
- Students leaving after the first fortnight of the Summer Term will be liable for the full year’s fees.
Facilities for Students

My Birkbeck
The My Birkbeck Student Advice Centre is your first point of reference for support during your studies with us - with a team of friendly and helpful staff on hand to provide the information and advice you need. If you need more specialist advice, our team will be able to refer you to the right person for more in-depth professional support, as well as book you an appointment with an advisor. We can help you with:

- all your application and enrolment queries
- general information about any aspect of your studies at Birkbeck
- getting referred to specialist staff for more in-depth professional support
- making an appointment for one-to-one advice
- general information about all our courses at Birkbeck

The My Birkbeck Student Advice Centre is based in the main Birkbeck building. Our staff are on hand to provide the information and advice between 12 – 6.45pm Mondays to Fridays, and 12 – 5pm on Saturdays. If you can't come in, you can phone us on 0845 601 0174. Phone lines are open between 9am and 6pm Monday to Friday. If calling from outside the UK: +44 (0)20 7631 6249 / 6435 / 6692. You can also use the self-service terminal to access information.

There is an extensive My Birkbeck website (www.bbk.ac.uk/mybirkbeck/) which contains a range of information, including

- guides designed for different groups of students so whether, for example, you're a certificate-level student, a PhD student or studying in Stratford, you can use these guides to find the information most relevant to you.
- all the procedural information you need, from application, enrolment and registration, to exams and assessment.
- a range of student support services, including learning support and skills training, careers advice, computing and IT support and library services.
- information on your student records, student card(s), getting proof that you're a student and other personal information.

Disability Support
At Birkbeck there are students with a wide range of disabilities including dyslexia, visual or hearing impairments, mobility difficulties, mental health needs, medical conditions, respiratory conditions. Many of them have benefited from the advice and support provided by the College’s Disability Office.

The Disability Office
The College has a Disability Office located in room G12 on the ground floor of the Malet Street building. We have a Disability Service Manager, Mark Pimm, a Disability Administrator, John Muya and a Mental Health Advisor, Elizabeth Hughes. We will shortly be appointing an SpLD Advisor.

All enquiries should come to the Disability office, who will determine the appropriate referral to specialist staff. They can provide advice and support on travel and parking, physical access, the Disabled Students Allowance, special equipment, personal support, examination arrangements etc. If you have a disability or dyslexia, we recommend you come to our drop in session where we can discuss support and make follow up appointments as necessary. The drop-in sessions are between 4pm and 6pm Monday to Thursday.
The Disability Office can also complete an Individual Student Support Agreement form with you, confirming your support requirements and send this to your School and relevant Departments at the College so they are informed of your needs.

Access at Birkbeck
Birkbeck's main buildings have wheelchair access, accessible lifts and toilets, our reception desks have induction loops for people with hearing impairments and we have large print and tactile signage. Disabled parking, lockers, specialist seating in lectures and seminars and portable induction loops can all be arranged by the Disability Office.

The Disabled Students Allowance
UK and most EU students with disabilities on undergraduate and postgraduate courses are eligible to apply for the Disabled Students' Allowance (DSA). The DSA usually provides thousands of pounds worth of support and all the evidence shows that students who receive it are more likely to complete their courses successfully. The Disability Office can provide further information on the DSA and can assist you in applying to Student Finance England for this support.

The Personal Assistance Scheme
Some students need a personal assistant to provide support on their course, for example a note-taker, sign language interpreter, reader, personal assistant, disability mentor or dyslexia support tutor. Birkbeck uses a specialist agency to recruit Personal Assistants and they can assist you with recruiting, training and paying your personal assistant. Please contact the Disability Office for information on this scheme.

Support in your School
The provision which can be made for students with disabilities by Schools is set out in the Procedures for Students with Disabilities. This is available from the Disability Office and on the disability website (see below).

As mentioned above your School will receive a copy of your Individual Student Support Agreement from the Disability Office. This will make specific recommendations about the support you should receive from the School.

Whilst we anticipate that this support will be provided by the Programme Director, tutors and School Administrator in the School of Arts also has a Student Disability Liaison Officer. If you experience any difficulties or require additional support from the School then they may also be able to assist you. They may be contacted through the School Office or the Disability Office.

Support in IT Services and Library Services
There is a comprehensive range of specialist equipment for students with disabilities in IT Services. This includes software packages for dyslexic students (e.g. Claroread and Inspiration), screen reading and character enhancing software for students with visual impairments, specialist scanning software, large monitors, ergonomic mice and keyboards, specialist orthopaedic chairs etc. For advice and assistance please contact Disability IT Support. There is also a range of specialist equipment in the Library including a CCTV reading machine for visually impaired students as well as specialist orthopaedic chairs and writing slopes. The Disability Office refers all students with disabilities to the Library Access Support service who provides a comprehensive range of services for students with disabilities.

Specific Learning Difficulties (Dyslexia)
Mature students who experienced problems at school are often unaware that these problems may result from their being dyslexic. Whilst dyslexia cannot be cured, you can learn strategies, which make studying significantly easier. If you think you may be dyslexic you should contact the Disability Office who can screen you and where appropriate refer you to an Educational Psychologist for a dyslexia assessment. These assessments cost £225. Some students can receive assistance in meeting this cost from their employer. In exceptional cases students may receive assistance from the Access to Learning Fund.
Examinations
Students with disabilities and dyslexia may be eligible for special arrangements for examinations e.g. extra time, use of a word processor, amanuensis, enlarged examination papers etc. In order to receive special arrangements a student must provide medical evidence of their disability (or an Educational Psychologists report if you are dyslexic) to the Disability Office. For School examinations you should contact your Programme Director to request special arrangements at least 2 weeks before the examination. For main College summer examinations you are given the opportunity to declare that you require special provision on your assessment entry form. Students who require provision should then attend an appointment with the Disability Office to discuss and formalise the appropriate arrangements. The closing date for making special examination arrangements in College examinations is the 15th March and beyond this date consideration will only be given to emergency cases.

Further information
Full information on disability support can be found at:
http://www.bbk.ac.uk/mybirkbeck/services/facilities/well-being-service/disability
You can contact the Disability & Dyslexia Service by emailing disability@bbk.ac.uk or by calling 020 7631 6316, where you will be able to speak to one of the Wellbeing Service Administrators.

Computing
All students are given an account on the College network which is activated on payment of fees. This gives access to College and Department resources, the web and an (optional) email account. Usernames and passwords can be obtained from the Department Help Desk (see below) on production of a College Membership Card.

The Department provides computing support for all Department students. Because you will need to submit a typed mathematics dissertation at the end of your MSc, you will need to learn about the mathematical typesetting package LaTeX. We will be running several training sessions in this package as part of the “Writing Mathematics” module, and providing help and support with installation and using the package. For more general help, IT Services (ITS) (http://www.bbk.ac.uk/its) is a College service that supports students throughout the College. The seventh floor notice boards have information on courses, software and hardware offers and other computer services.

Department Student Help Desk
The Help Desk is run by the Department computing staff:
Nigel Foster (room 759), tel 020 7631 6402, and Awuku Danso (room 758), tel 020 7631 6433.

Email: helpdesk@ems.bbk.ac.uk at the following times:

Term: Mon – Fri 16.00 – 18.00
Vacations: Mon – Thurs 16.00 – 18.00

ITS Reception Help Desk
Ground floor, Main Building, Tel.: 020 7631 6543.
Term: Mon – Fri 09.00 – 20.00
Vacations: Mon – Fri 10.00 – 18.00

Workstation Rooms
The Department has its own Workstation Room, Room 742, for specialized software. For more general software, ITS run the following Workstation Rooms:
• Rooms 10 and 11, 43 Gordon Square; Rooms 109, 412, 413, 422, 423 and 536
Library

Although lectures are an essential element of your programme, success in learning also depends on the additional study and reading that you undertake. Most items on module reading lists can be found in Birkbeck Library and it is important that you familiarise yourself with the Library as soon as you can. Birkbeck Library is accessible from the ground floor of the main Malet Street building (entrance on Torrington Square). Your College ID card gives you automatic access to the Library. There is no need to register. The opening times of the Library are designed to meet the needs of part-time students in full-time work. During term-time the Library is open:

- 7 days a week 8.30am – 11.45pm.

The Library is fully staffed for most of the above hours but self-service machines allow you to take out and return books when the Library is not staffed:

- Before 10.00am every day.
- After 10.30pm week days.
- After 6.00pm on Saturdays and Sundays.

You can borrow up to 15 items and they can be renewed as long as no-one else requests them. Most books can be borrowed for 3 weeks. Some books, videos and DVDs can be borrowed for 1 week. A few items can only be issued for 1 day. There is also a Reading Room Collection with reference access to key course readings.

Please be a responsible Library user. The smooth running of the Library depends on your co-operation. Please renew or return items promptly, especially if someone else has requested them. If you fail to return items on time you will incur fines and your borrowing rights will be suspended.

Birkbeck eLibrary

You can access a whole host of electronic journals and databases from any PC in College. These resources can also be accessed from outside College with your IT Services (ITS) username and password. The Library website is at http://www.bbk.ac.uk/lib/. As well as giving comprehensive information about the Library’s services and collections, you can also:

- Search the Library catalogue, renew books and place reservations on items that are out on loan.
- Read articles in over 25,000 full-text electronic journal titles and newspapers.
- Search databases to help you find out what has been written about the subject you are researching, including the Current Index to Statistics, MathSciNet, Science Citation Index and Social Science Citation Index.
- Access past exam papers.
- Work through LIFE – an online tutorial to help you make the most of the Library.

Other libraries

Birkbeck students can also use other libraries. Students have reference access to most University of London college libraries. Part-time students can also join the SCONUL Access Scheme, see , allowing access to most other higher education libraries with limited borrowing rights. See the Library web site for more information.

Further information and help

If a book you need is not available in the Library or you require any help using the resources or finding information, please ask at the help desk (020 7631 6063). Alternatively, contact your Subject Librarian, Aidan Smith, directly. Telephone: 020 7631 6062.
Careers
Most students are interested in developing their careers, either within their current field of work or in a completely new direction. The Specialist Institutions’ Careers Service [SICS], part of The Careers Group, University of London, offers great expertise and experience in working with students and graduates of all ages and at all stages of career development. SICS is located on the 1st Floor of Stewart House, 32 Russell Square, London, WC1B 5DN. Enrolled students of Birkbeck who are following degree programmes may use the services of SICS free of charge up to the end of July of the year they finish. Services include:

- **An Early Evening Advisory Service** specifically for evening students on Wednesdays in term-time from 5pm to 7pm. You must pre-book by 12 noon on Wednesdays by calling 020 7866 3600 or emailing
- **Drop-In Advice Service** - Monday-Thursday, 14.00-16.30.
- Longer **Advisory Interviews** can be arranged - for career beginners, for people wanting a practice job interview, and for every stage and situation in between.
- They also offer **Psychometric Testing and Personality Assessment Workshops, Employer Presentations, Computer-based Career Guidance Programs, Insight Career Courses** as well as invaluable information on Course Funding.

For more information visit The SICS website.

Employability - Careers and Employability Service

We provide comprehensive careers, recruitment and employability advice, events and information services for our students, both online and face-to-face at our dedicated support space on the Birkbeck campus in Bloomsbury. These include: speaking to a careers advisor; panel discussions with employers, Birkbeck alumni and careers consultants; workshops and events on finding work, CV and application writing, and preparing for interviews; and online social media support.

We also work closely with Birkbeck Talent, our in-house recruitment service, to provide bespoke support for student pursuing employment and internship opportunities.

To find out more, visit [bbk.ac.uk/careers](http://bbk.ac.uk/careers)

*Birkbeck Talent: a dedicated in-house recruitment service for students*

Birkbeck Talent is a professional recruitment service aimed exclusively at assisting Birkbeck students to find work whilst studying and after graduation. We work with London’s top employers to offer innovative internships, prestigious job vacancies and exciting graduate opportunities.

To find out more, visit [bbk.ac.uk/talent](http://bbk.ac.uk/talent)

Business Engagement team

The School of Business, Economics and Informatics has a dedicated Business Engagement team where you can take advantage of extra support - in addition to what is offered by Birkbeck Talent and Birkbeck Careers.

The Business Engagement team deliver a range of activities to support you in your career aspirations including:
Mentoring Pathways
Mentoring Pathways pairs successful applicants with industry professionals for individual advice and guidance. There are approximately 100 places available for final year undergraduates and postgraduate students. We have partnerships with a number of key organisations and work alongside Birkbeck alumni who provide mentors. Please email mentoring@bbk.ac.uk

Enterprise Pathways
Whether you are setting out in your journey as an entrepreneur or have already established a thriving business, we offer various pathways to support you. These include a non-credit bearing module with workshops once a month throughout the academic year, access to digital resources, and enterprise boot camps to help you to develop your ideas and network with other students. Please email enterprise@bbk.ac.uk or visit www.bbk.ac.uk/enterprise

School Events
From time to time we run events, competitions or offer the opportunity to attend conferences, with the aim to help you to find out more about industry sectors, entrepreneurs and professional bodies.

Insiders’ Guides
We take a small number of students to visit workplaces and ask questions about the culture, the roles and career progression. If you would like to participate please email developus@bbk.ac.uk

Employer Sponsorship
Talk to a member of the team about how your current employer might sponsor you through your studies. Please email: developus@bbk.ac.uk

You can also follow BEI on social media for information and conversations:

• Twitter: @BirkbeckBEI
• Facebook, Google+ and LinkedIn: Search ‘BirkbeckBEI’

Please visit our website www.bbk.ac.uk/business/business-services for resources and information about all of these initiatives.

We send a regular email newsletter with details of all upcoming events and activities to students in the School of Business, Economics and Informatics who allow marketing communications through their MyBirkbeck Profile.

BUSINESS ENGAGEMENT EVENT SCHEDULE 2016/17

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<th>Month</th>
<th>Enterprise Pathways</th>
<th>Mentoring Pathways</th>
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<tr>
<td>October</td>
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<td>Briefing sessions</td>
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<td>Week commencing 31/10/16</td>
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<td>November</td>
<td>Community Launch &amp; Brunch</td>
<td>Training sessions</td>
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<td>05/11/16</td>
<td>Weeks commencing 12/11/16 and 19/11/16</td>
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<td>16/11/16</td>
<td>Global Entrepreneurship Week Event</td>
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<td>21/11/16</td>
<td>Launch event</td>
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<tr>
<td>03/12/16</td>
<td>December Who are you? What type of entrepreneur can you be?</td>
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<td>03/12/16</td>
<td>1-1 Mentoring</td>
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<td>07/01/16</td>
<td>January Get LEAN</td>
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<td>04/02/16</td>
<td>February Dynamic Business Plans</td>
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<td>04/03/16</td>
<td>March Pitch Perfect and Santander Competition Launch</td>
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<td>01/04/16</td>
<td>April Sources of Finance</td>
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<td>06/05/16</td>
<td>May Take-off</td>
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<td>03/06/16</td>
<td>June Birkbeck Angels</td>
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<td>15/07/16</td>
<td>July Awards Evening</td>
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<td>05/07/16</td>
<td>Celebration event</td>
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The Students' Union

Birkbeck Students' Union provides a wide range of services for students. As well as organising various social events and running many student societies, it provides a free counselling service for any student seeking counselling and a drop-in advice centre where you can go to discuss any problems, academic or otherwise, that you may be having. The union runs popular study skills sessions which many people find very useful, particularly those who may have been away from formal education for a while. For further information email the organisers at or phone on 0207 631 6335. The students' union website at provides information about all these services and more.

Refreshments and other facilities

Malet Street Fifth Floor Eatery (Room E505, 5th Floor Ext., Malet Street)
Located in the extension building in Malet Street, the Fifth Floor Eatery offers a wide selection of sandwiches, soup, pasties, cakes, confectionery, hot and cold beverages for a quick and easy grab and go service. They also offer a wide range of classic & modern meals, daily vegetarian choices, jacket potatoes, salads & made to order deli-bar & light bites. Opening hours are as follows:

Term-time - Monday to Friday: 10.00 - 20.00.
Out of term - Monday to Friday only: 10.00 - 16.00.

Lunch time hot food service is 12.00 to 2.30. Dinner time service is 5.00 to 7.00.

Café on the Square (Costa Coffee)
Located on the ground floor of the Malet Street building facing Torrington Square you will find a 'Fair Traded' Costa Coffee outlet with freshly baked pastries and muffins, a premium range of Panini, sandwiches & snacks. Opening Hours:

Term-time - Monday to Friday: 08:30 – 20:00.
Saturday 08:30 – 19.00; Sunday 09:30 – 19:00
Out of term - Monday to Friday only: 08:30 – 17:00.
Saturday 9.00 – 17.00; Sunday 10.00 - 17.00

Gordon Square Snack Bar (42-47 Gordon Square)
The snack bar on the Ground Floor of the Gordon Square site offers a choice of cakes, sweets, sandwiches and savouries, as well as hot and cold drinks. Term-time opening hours are 9am – 8pm, Monday to Friday and 10am-7pm Saturday.

The Union Shop
The Union Shop (in the basement of the Malet Street building) stocks drinks, snacks, stationary, some medicines and Birkbeck memorabilia such as scarves, ties, and fleeces. The Union Shop also issues NUS cards and is run by Union Assistants who are able to provide information about the Union and its services.

Birkbeck College Bar
The bar is on the 4th floor of the Malet Street building. It is open Monday to Friday, 12-2pm and 5-11pm. There is a pool table and plasma screen TV.

University of London Union Facilities
The College pays an annual subscription to the University of London Union, so all Birkbeck Degree students are automatically full members. This means that you have access to all the Clubs & Societies, bars and sports facilities that ULU has to offer. You can get a ULU membership card from the Union Office if you show your college ID card and provide a passport photograph.
ULU is the central Students’ Union for the University of London. It represents the interests of students throughout the University, complimenting the activities of Birkbeck Students’ Union and the Unions of the other Colleges. At its main building in Malet Street (next door to Birkbeck) ULU provides a range of facilities and services. There is a shop, opticians, photocopying facilities, coffee shop, bars, a café and a gym and swimming pool with reduced membership fees for students. The ULU Website has full details: http://www.ulu.lon.ac.uk.

Childcare
Birkbeck runs an evening nursery for the children of students (and staff) and accepts children aged 2 years - 9 years. In exceptional circumstances, children up to 12 will be accepted. The Nursery is open from 5.30pm - 9.00pm (Monday to Friday) during Term Time at a cost of £15 per evening, per child. Payment is on a nightly basis (cheques payable to Birkbeck College).

The Nursery gets subscribed very quickly. To enrol your child you should complete, as soon as possible, the Application Pack documents that are available for download at http://www.bbk.ac.uk/mybirkbeck/services/facilities/nursery.

Your Programme of Study
The MSc in Mathematics and MSc in Mathematics and Financial Modelling at Birkbeck are two-year programmes specially designed for part-time study. All teaching takes place in the evenings, making it ideal for those who have daytime commitments. Some terminology: to get an MSc Mathematics or MSc Mathematics and Financial Modelling you need to gain a total of 180 credits. Each module has a credit value of either 15, 30 or 60 credits. Modules are also assigned a numerical level of difficulty. Postgraduate modules are level 7, and you must take at least 150 credits at this level. Final year undergraduate modules (or modules at an equivalent academic level) are level 6, and you may take at most 30 credits at level 6 as part of your MSc programme. The academic year is split into three terms. The bulk of teaching takes place in the Autumn and Spring terms. In the Summer term, there are revision lectures, followed by the examination period. Terms are eleven weeks long.

The dissertation that you submit at the end of your second year is worth 60 credits at level 7, so over your two years you will need to pass 120 credits worth of taught modules. We highly recommend that one of your modules in year 1 be the 15 credit, level 7 module Writing Mathematics. It teaches you how to write and create mathematical documents on your computer using a dedicated mathematical typesetting package. Without this you will find it very difficult to type up your dissertation. This module is assessed solely by coursework, meaning that there is one less examination to worry about in the summer! We normally suggest that you take this module, plus 60 credits of taught modules, in your first year, and then another 45 credits of taught level 7 modules, plus your 60 credit dissertation, in your second year. This means that you have a little less work on taught modules in your second year, allowing you to spend more time on your dissertation.

Most of your taught modules will be one-term, 15 credit level 7 modules, with ten evenings of lectures in weeks 1– 5 and 7 – 11, plus one revision lecture in the summer term. Usually there are no lectures in the middle week of term – this is to allow you a week’s break to consolidate your work so far. Any 30 credit modules will run all year, with with 8-10 evenings in the Autumn Term, 8-10 evenings in the Spring Term (depending on the module), plus 2 revision lectures in the Summer Term.

MSc in Mathematics
You will have the chance to study a range of topics in pure and applicable mathematics, with the focus on algebra, discrete mathematics and applications such as coding theory and cryptography. The programme consists of 120 credits of taught modules, worth either 15 credits or 30 credits each, and a dissertation worth 60 credits.
You usually take modules to a total of 75 credits in Year 1, including the 15-credit module Writing Mathematics, which teaches you how to use the program LaTeX to produce mathematical documents. This module consists of 8 evenings of tutorials over the course of the year. Every other 15-credit module runs for 1 term, while each 30-credit module runs for 2 terms. You can take a maximum of 30 credits at Level 6 for your MSc, while the remaining modules you take must be at Level 7.

In Year 2, you take 45 credits of taught modules, and you also complete a project worth 60 credits, which will allow you to investigate in depth a particular area of mathematics that interests you. You will have help and guidance through the process from your supervisor. At the end of your second year you will submit a dissertation and give an oral presentation about your work.

MSc in Mathematics and Financial Modelling

Birkbeck’s MSc in Mathematics and Financial Modelling is a part-time programme that combines the study of mathematics at postgraduate level with a strong component of financial mathematics and modelling. The programme offers you the chance to study a range of modules in pure and applicable mathematics, as well as financial mathematics, thus giving you the opportunity to increase your knowledge and abilities in these areas.

The programme comprises 120 credits of taught modules and a 60-credit dissertation. There are 2 core modules that you must pass to gain the MSc Mathematics and Financial Modelling: Mathematical and Numerical Methods, and Pricing.

In Year 1, you usually take 75 credits of taught modules, including the coursework-only module Writing Mathematics, which teaches you to use the program LaTeX to produce mathematics documents. It is a 15-credit module, with 8 evenings of tutorials over the course of the year. Each of the other 15-credit modules run for 1 term and each 30-credit module runs for 2 terms.

Other modules can be chosen from the list of options to suit your interests and expertise. You may take at most 30 credits of modules at Level 6, with the remaining 90 credits of modules at Level 7. The Programme Director can offer you advice on the most suitable choice of option modules, given your experience, prior study and future goals.

In Year 2, you take 45 credits of taught modules, and you also complete a dissertation worth 60 credits. This allows you to engage in a sustained investigation of an area that interests you within statistics and/or finance, implementing what you have learned from the taught modules on the programme and combining this knowledge with new research and analysis.

Timetable

The majority of our taught modules run biennially, so that in your two years here you have the opportunity to choose from the full range of modules. The timetable for this year’s modules is fixed and given below; the timetable for next year is of course only provisional at this stage. **Year 1** Take taught modules to the value of 60-75 credits. Begin thinking about choice of project topic (you will get help and advice in making your choice). Project proposal to be submitted at the start of year 2. The modules available for 2016-17 are listed below.

### 2016-17 Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Level</th>
<th>Credits</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebraic Number Theory</td>
<td>7</td>
<td>15</td>
<td>Tuesdays, Autumn Term</td>
</tr>
<tr>
<td>Module</td>
<td>Level</td>
<td>Credits</td>
<td>When</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
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<td>---------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Computational Mathematics</td>
<td>6</td>
<td>30</td>
<td>Fridays, Autumn and Spring</td>
</tr>
<tr>
<td>Continuous Time Stochastic Processes I (first half of Mathematical &amp; Numerical Methods, only available to MSc Mathematics students)</td>
<td>7</td>
<td>15</td>
<td>Mondays, Autumn Term</td>
</tr>
<tr>
<td>Continuous Time Stochastic Processes II (second half of Mathematical &amp; Numerical Methods, only available to MSc Mathematics students)</td>
<td>7</td>
<td>15</td>
<td>Monday, Spring Term</td>
</tr>
<tr>
<td>Enumeration</td>
<td></td>
<td></td>
<td>Thursdays, Autumn Term</td>
</tr>
<tr>
<td>Pricing (only available to MSc Mathematics and Financial Modelling students)</td>
<td>7</td>
<td>30</td>
<td>Tuesdays, Autumn and Spring</td>
</tr>
<tr>
<td>Group Theory</td>
<td>7</td>
<td>15</td>
<td>Monday, Spring Term</td>
</tr>
<tr>
<td>Mathematical and Numerical Methods</td>
<td>7</td>
<td>30</td>
<td>Wednesdays Autumn and Spring Term</td>
</tr>
<tr>
<td>Mathematics of Communications</td>
<td>7</td>
<td>15</td>
<td>Thursdays, Spring Term</td>
</tr>
<tr>
<td>Number Theory and Geometry</td>
<td>6</td>
<td>30</td>
<td>Tuesdays, Autumn and Spring</td>
</tr>
<tr>
<td>Topics in Graph Theory</td>
<td>7</td>
<td>15</td>
<td>Monday, Autumn Term</td>
</tr>
<tr>
<td>Writing Mathematics</td>
<td>7</td>
<td>15</td>
<td>Fridays, 4 Autumn, 4 Spring</td>
</tr>
</tbody>
</table>

Note that the Writing Mathematics classes will be timetabled not to clash with any level 7 classes.

**Year 2**

Take taught modules to the value of 45-60 credits, and complete the Mathematics Dissertation. Work on your project continues throughout the year, with submission by September 1st at the end of the second year, and oral presentation in mid-September.

The modules PROVISIONALLY planned for 2017-18 are:

<table>
<thead>
<tr>
<th>Module</th>
<th>Level</th>
<th>Credits</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Programming &amp; Game Theory</td>
<td>7</td>
<td>30</td>
<td>Mondays, Autumn and Spring</td>
</tr>
<tr>
<td>Continuous Time Stochastic Processes I (first half of Mathematical &amp; Numerical Methods, only available to MSc Mathematics students)</td>
<td>7</td>
<td>15</td>
<td>Mondays, Autumn Term</td>
</tr>
<tr>
<td>Continuous Time Stochastic Processes II (second half of Mathematical &amp; Numerical Methods, only available to MSc Mathematics students)</td>
<td>7</td>
<td>15</td>
<td>Mondays, Spring Term</td>
</tr>
<tr>
<td>Mathematical &amp; Numerical Methods</td>
<td>7</td>
<td>30</td>
<td>Wednesdays, Autumn and Spring</td>
</tr>
<tr>
<td>Pricing (only available to MSc Mathematics and Financial Modelling students)</td>
<td>7</td>
<td>30</td>
<td>Tuesdays, Autumn and Spring</td>
</tr>
<tr>
<td>Calculus 3: Transforms &amp; Models</td>
<td>6</td>
<td>30</td>
<td>Tuesday, Autumn &amp; Spring</td>
</tr>
<tr>
<td>Galois Theory</td>
<td>7</td>
<td>15</td>
<td>Thursdays, Spring Term</td>
</tr>
<tr>
<td>Topology</td>
<td>7</td>
<td>15</td>
<td>Wednesdays, Spring Term</td>
</tr>
<tr>
<td>Reflection Groups</td>
<td>7</td>
<td>15</td>
<td>Wednesdays, Autumn Term</td>
</tr>
<tr>
<td>Representation Theory</td>
<td>7</td>
<td>15</td>
<td>Thursdays, Autumn Term</td>
</tr>
<tr>
<td>Writing Mathematics</td>
<td>7</td>
<td>15</td>
<td>Fridays, 4 Autumn, 4 Spring</td>
</tr>
</tbody>
</table>
Your time commitment

Depending on your choice of options, you will have between two and three evenings of lectures a week in the Autumn and Spring Terms, one evening per module. Lectures take place from 6-9pm, usually with a break in the middle of the evening. You are expected to spend time studying outside of lectures, consolidating what you have learnt, isolating any areas of difficulty, trying examples and practice questions from lectures and books, and so on. A rough guideline would be that for each hour of lectures, you should spend at least an hour of private study, plus the time spent completing coursework and revising for exams. Note that each credit notionally represents one hour of study – this is based on the assumption that a full time MSc student works 40 hours a week for 45 weeks.

You will receive assignments on a regular basis, usually two per 15 credit module and four per 30 credit module. You will have at least three weeks to complete each one.

The Summer Term is devoted primarily to revision and the exam period. You will have one examination for each module. Exams take place during the day, so if you are in employment you will need to arrange time away from work for the exams. As your first year progresses you will need to be thinking about your project. Over the summer after your first year exams you will prepare a project proposal. Then throughout your second year work will begin in earnest on the project, with the final dissertation due to be submitted by September 1<sup>st</sup> at the end of your second year, and project presentations during September.

Study skills

At Birkbeck, every student is a part-time student, and we recognise the particular difficulties that this can bring. Many of you are juggling jobs and family with your studies. It may be quite a few years since you last went to a lecture, took notes or did “homework”. It can all seem rather daunting at first. We find that the students who succeed are the ones who are well organised, keep their notes up-to-date and work consistently throughout the year. The most important thing to remember is that, just as you can’t learn to drive a car by watching someone else, mathematics is best learned by doing. So try examples, work through exercises and don’t be too quick to look at any solutions you’ve been given.

Tackling Problems Early

If you find there is something you haven’t understood from lectures, it is best to sort it out as soon as possible. Because mathematics tends to build on earlier foundations, you may find that if you ignore a topic you haven’t understood in week 2, it will become increasingly harder to understand what’s going on. This means you fall further behind. So tackle problems early. If there’s something during a lecture that you don’t follow, please do raise it at the time. Usually the lecturer will be able to answer the question quickly and then you can understand the rest of the lecture. After the lecture, it’s helpful to test your understanding by reading through your notes and making sure you follow all the steps in the arguments given by the lecturer. Try some examples or exercises from the notes, or a book. If you are still having difficulty, do ask the lecturer.

Organising your work

It is useful to organise your notes in some way, rather than just shoving everything into a big folder. One good method is to have a folder or ring-binder for each module, containing lecture notes (both typed from the lecturer and your own handwritten ones), any question sheets and solution sets, your own attempts at exercises, assignments and so on. These could be arranged in chronological order. Then whenever you sit down to work on that particular topic, you will have all the materials at hand. If you have the space at home, a dedicated (quiet!) study area is a good idea, where you can keep your books, folders, calculator and stationery all in one place.

Assignments
When attempting assignments, remember that they are supposed to test whether you understand what you have been taught. So your first port of call if you are stuck should be the lecture notes. From them you can get the definitions of words used, and maybe even worked examples similar to the questions you have been set. Many students are tempted by the lure of the internet, and type in likely looking words to see if they can find the answers somewhere. There are several pitfalls to doing this. First, if you don’t actually understand the mathematics involved, you’re probably unlikely to be able to use what you find to answer the questions. Secondly, there is no quality control on the internet and pages are often full of errors. And finally, on the whole, you won’t be able to find the answer to the question, because the odds of someone somewhere choosing to answer that exact question and out of the goodness of their heart post the answer on their webpage are vanishingly small. It’s far better to concentrate on what you have actually learned in lectures as a starting point. If you are having difficulties, ask the lecturer for guidance. **Note that plagiarism is an offence which we take very seriously – your answers for an assignment should be all your own work, so you must not copy from another student. It is also an offence to allow another student to copy your work. See the section on plagiarism for more details.**

**Meeting Deadlines**

Everyone knows that if you have a task to do, it’s best to tackle it bit by bit, start well before the deadline and give yourself lots of leeway over when you finish so that if the unexpected happens, such as illness, you still have time to finish. This is as true for studying as for anything else. Try to set aside regular times when you are going to study, work on assignments and so on. It is much easier to do coursework at a relaxed pace while it’s fresh in your mind than at midnight the day before the deadline when it’s 3 weeks since you were studying the topic in class. It is important to hand in work on time, as the College coursework policy means that **late coursework scores a maximum of 50%**, even if every question is correct. Coursework usually accounts for 20% of the marks for a module, which may not seem much, but there are examples of students failing modules because they didn’t hand in coursework. You have been warned!

**‘Skills for Study’ Programme**

The Students’ Union has designed a series of ‘Skills for Study’ workshops on weekday evenings. Sessions include: essay writing skills; presentation skills; reading skills, effective note taking; time management; revision skills; exam skills, time and stress management Further information from administrator@bcsu.bbk.ac.uk, tel: 020 7631 6335.

**Modules**

In this section you will find more detail about individual modules. Unless otherwise stated it is not compulsory to buy the recommended texts. For most modules everything you need to know will be covered in lectures. Copies of each recommended book are available in the college library and are an extra resource if you want more practice of the work covered in lectures. Full details about each module, along with course materials such as assignments, are posted online at . Course materials for many modules will be placed on Birkbeck’s virtual learning environment Moodle. To access these you will need to be registered for that module, and have your Birkbeck username and password. Then just login at http://moodle.bbk.ac.uk/ .
Algebraic Number Theory (BUEM034H7)

15 credits, level 7

Aims
This module aims to introduce students to the concepts of Algebraic Number Theory including Number Fields and their Rings of Integers and Ideal Class Groups. In particular, the student will know by the end of the course how to compute quantities such as Norms, Traces and Class Numbers. The course is stand alone but will also serve as training for students wanting to pursue research into many aspects of Number Theory.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

Syllabus
- Definition of Ideal Class Groups. Proof of finiteness. Class Numbers. Statement (without proof) of Minkowski's theorem on convex bodies and its application to the problem of computing class numbers.
- Dedekind's Theorem on the factorisation of primes and its application to quadratic fields.
- Discussion of cyclotomic fields and Fermat's Last Theorem. If time permits, discussion of applications of these ideas to other Diophantine equations may be given.

Recommended Texts
Calculus 3: Transforms and Models (BUEM021S6)

30 credits, level 6

**Aims**
The important ideas of the Laplace Transform and Fourier series will be introduced, and their applications in solving other problems in Calculus will be considered. Systems of differential equations will be studied, and used to model and investigate problems in the natural and social sciences.

**Teaching and Assessment**
Teaching for this module will take place throughout the year, with eight evenings of lectures in each of the Autumn and Spring Terms and two evenings of revision and consolidation in the Summer Term.

Of the final course mark, 80% is based on a three-hour exam in the summer term and the other 20% is from assessed coursework.

Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

The examination in the summer term will consist of 8 short (5 mark) questions, which are compulsory, and 4 long (20 mark) questions from which candidates must answer two.

**Syllabus**

**Laplace Transforms**
The Laplace transform of elementary functions, properties of the Laplace transform, inversion of the Laplace transform, solving differential equations using Laplace transforms, the convolution of two functions, some families of integral equations, the z-transform and discrete systems.

**Fourier Series**
Periodic functions, the Fourier series of a function, finding the coefficients of a Fourier series, the range of validity of a Fourier series, even and odd functions and their Fourier series, half range Fourier series and the relationship between them and the corresponding Fourier series, application of Fourier series in the solution of partial differential equations, the Fourier transform.

**Dynamical systems**
Systems of linear differential equations, coupled systems, autonomous systems, stability, critical points, phase plane analysis, trajectories, fixed solutions, periodic solutions, chaotic systems.

**Models**
The methods introduced in the module will be to model and interpret problems in the natural and social sciences covering some the following: mixing problems, tests for diabetes, nutrient exchange in the placenta, competing species, predator-prey models, the Lotka-Volterra equations, the transfer of heat, the arms race and combat, finance and economics.

**Recommended Texts**
- W.E. Boyce and R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*
Computational Mathematics (BUEM010S6)

30 credits, level 6

Aims
This module introduces the mathematics of computation, and involves the implementation and analysis of both exact and numerical algorithms. Ideas introduced in earlier modules will be developed in greater depth, giving a deeper and more thorough understanding of the topics covered, and illustrating the inter-relationships between different branches of mathematics.

Teaching and Assessment
Teaching for this module will take place throughout the year, with eight evenings of lectures in each of the Autumn and Spring Terms and two evenings of revision and consolidation in the Summer Term. Of the final course mark, 80% is based on a three-hour exam in the summer term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one. The examination in the summer term will consist of 8 short (5 mark) questions, which are compulsory and 4 long (20 mark) questions from which candidates must answer two.

Syllabus

- **Sorting** Algorithms for sorting a list: exchange sort, insert sort, merge sort, quick sort, heap sort; divide and conquer algorithms, rooted trees, binary trees, sifting procedures.
- **Asymptotic behaviour of functions** Comparing growth rates of functions, Big O notation, partial orders on a set of functions based on growth rate, the maximum rule, the relationship between the growth rate of functions f and g and the limit of f(n)/g(n) as n tends to infinity, other asymptotic concepts: Omega and Theta notation.
- **Time complexity of an algorithm** Analysis of an algorithm through counting significant operations, analysis of sorting algorithms, algorithms from linear algebra and graph theory, worse case and average case time complexity.
- **Computational Complexity** Comparison of polynomial and exponential growth; P, NP and NP-complete problems; examples of problems that are in P, examples of problems that are in NP but not known to be in P, examples of NP-complete problems; the SAT problem.
- **Errors** Sources of error: rounding errors, truncation errors, underflow and overflow; representing approximations of a real number and fixed point arithmetic, ill-condition problems.
- **Systems of linear equations** Gauss elimination and its computational time complexity; errors arising due to rounding; LU decomposition and iterative refinement; matrix and vector norms and error estimation; tests for determining ill conditioned equations; the Jacobi and the Gauss-Seidel iterations and conditions for their convergence.
- **Nonlinear equations** Methods for finding the approximate root of a nonlinear equation: bisection, fixed point iteration, Newton-Raphson; tests for the convergence of these methods and the speed of convergence, the order of a process; roots of polynomials and the Horner scheme.
- **Polynomial interpolation and quadrature** Approximating a function by a polynomial, Lagrange polynomials, divided differences, forward differences, numerical integration: the rectangular rule, the trapezium rule, Newton-Cotes Formulas, composite rules, error estimation.
Continuous Time Stochastic Processes I (EMMS024H7)

15 credits, level 7

(Note: this is the first half of the module Mathematical and Numerical Methods)

Aims
To introduce students to continuous time stochastic processes, and to stochastic differential calculus, in particular the stochastic differential equations (SDE) that arise in quantitative finance, as well as many other applied areas. To introduce students to some of the main numerical solution techniques used to solve SDE. For more detail on the course, including past exam papers, see econ109.econ.bbk.ac.uk/brad/Methods.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. You will have around three weeks to complete each one.

Syllabus
- Review of probability theory, notion of a stochastic process.
- Examples of stochastic processes: Brownian motion and the Poisson process.
- Stochastic differential calculus: heuristic approach to stochastic differentials, Ito's lemma, rigorous approach to Ito's stochastic integral, multivariate Ito calculus.
- Stochastic differential equations (SDE), examples from financial modelling.
- Conditional expectation and martingales.
- Extensions of Ito calculus: jump diffusions, more general processes.
- Monte Carlo simulation of stochastic processes, Brownian motion.
- Numerical solutions of SDE.

On successful completion of this course students should be able to demonstrate:

- understanding of the basic theory of continuous time stochastic processes, in particular Brownian motion and the Poisson process;
- understanding of stochastic differential calculus (Ito calculus) and the concept of a stochastic differential equation (SDE);
- knowledge of how to numerically simulate solutions to an SDE;
- the ability to manipulate stochastic integrals and use Ito's lemma;
- the ability to use and solve SDE's.

Recommended Texts
- Etheridge, A Course in Financial Calculus, Cambridge University Press. This does not focus on the algorithmic side but is very lucid.
- D. Higham, An Introduction to Financial Option Valuation, Cambridge University Press. This book provides many excellent Matlab examples, although its mathematical level is undergraduate.
- J. Hull, Options, Futures and Other Derivatives, 6th edition. [Earlier editions are probably equally suitable for much of the course.] Fairly clear, with lots of background information on finance. The mathematical treatment is lower than the level of much of our course (and this is not a mathematically rigorous book), but it's still the market leader in many ways.
Continuous Time Stochastic Processes II (BUEM078H7)

15 credits, level 7

(Note: this is the second half of the module Mathematical and Numerical Methods)

Aims
This module aims to further expand on some of the mathematical techniques used in quantitative finance and to introduce the main numerical techniques used in the industry.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. You will have around three weeks to complete each one.

Syllabus

- The Binomial Model Universe.
- The Partial Differential Equation Approach: The Diffusion Equation; Finite Difference Methods for the Diffusion Equation; The Fourier Transform and the von Neumann Stability Test; Stability and the Fourier Transform; Option Pricing via the Fourier transform; Fourier Transform Conventions.
- Mathematical Background Material: Probability Theory; Differential Equations; Recurrence Relations; Mortgages - a once exotic instrument.

On successful completion of this course students should be able to demonstrate:

- Solve SDEs using Monte Carlo simulation.
- Understand the fundamental algorithms for the numerical solution of parabolic partial differential equations (PDEs).
- Understand the binomial method for option pricing as a finite difference method, particularly its disadvantages.
- Appreciate the importance of stability in numerical algorithms for PDEs.
- Understand numerical methods for the solution of nonlinear equations and some basic optimization techniques.
- Know the basics of relevant numerical methods, e.g. data fitting.
Illustrate the above by examples and exercises in a high level programming language/package, such as Matlab for example.

Recommended Texts

- Etheridge, A Course in Financial Calculus, Cambridge University Press. This does not focus on the algorithmic side but is very lucid.
- D. Higham, An Introduction to Financial Option Valuation, Cambridge University Press. This book provides many excellent Matlab examples, although its mathematical level is undergraduate.
- J. Hull, Options, Futures and Other Derivatives, 6th edition. [Earlier editions are probably equally suitable for much of the course.] Fairly clear, with lots of background information on finance. The mathematical treatment is lower than the level of much of our course (and this is not a mathematically rigorous book), but it’s still the market leader in many ways.
- J. Michael Steele, Stochastic Calculus and Financial Applications, Springer. This is an excellent book, but is one to read near the end of this term, once you are more comfortable with fundamentals.
- P. Wilmott, S. Howison and J. Dewynne, The Mathematics of Financial Derivatives, Cambridge University Press. This book is very useful for its information on partial differential equations. If your first degree was in engineering, mathematics or physics, then you probably spent many happy hours learning about the diffusion equation. This book is very much mathematical finance from the perspective of a traditional applied mathematician. It places much less emphasis on probability theory than most books on finance.
Aims
This module will introduce students to selected topics in combinatorial enumeration. Many questions in disparate mathematical fields can be reduced to a counting problem of the sort “how many such objects are there?”. In this module students will explore some of the basic techniques in solving counting problems.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on an examination in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

Syllabus
A list of likely topics to be covered is:
- generating functions and their basic calculus;
- the Lagrange inversion formula including proofs;
- applications of generating functions to counting problems;
- integer partitions and associated series;
- permutation statistics;
- the principle of inclusion/exclusion;
- bijective techniques and proofs.

Recommended Texts
Galois Theory (BUEM046H7)

15 credits, level 7

Aims
Galois theory is a branch of abstract algebra that provides important connections between group theory and the theory of extension fields. This course aims to give students a suitable grounding in the algebra of fields, field extensions, and automorphism groups, and to provide an understanding of the relationships between them that make up the central tenets of Galois theory.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on an examination in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

Syllabus
- **Fields and Polynomials**
  - Rings; fields; extension fields; rings of polynomials over fields; prime fields
- **Extension Fields**
  - Vector spaces; algebraic extensions; ruler and compass constructions; finite fields
- **Automorphisms of Fields**
  - Examples of field automorphisms; fixed fields; splitting fields; separable extensions; perfect fields; primitive elements; normal extensions; Galois groups; the main theorem of Galois theory; the insolvability of the quintic

Recommended Text
**Group Theory (BUEM036H7)**

15 credits, level 7

**Aims**
The group theory module aims to introduce students to further topics in group theory, extending and building on material covered at undergraduate level. It is a stand-alone course but will also give students experience in the subject at postgraduate level which will be useful for those intending to pursue research in this area.

**Teaching and Assessment**
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

**Syllabus**
- Group Actions and G-sets. The Orbit-Stabilizer Theorem. Application of G-sets to the proof of Sylow’s Theorems. Use of Sylow’s Theorems to investigate groups of finite order. Discussion of simple groups.
- Direct products of groups; groups which are the direct product of their Sylow subgroups; classification of finite abelian groups as direct products of certain cyclic groups.
- Revision of Quotient groups; the three Isomorphism Theorems. Normal series, composition series, chief series. The Jordan-Holder Theorem; composition factors and chief factors; definition of soluble groups; showing that a given group is or is not soluble; examples.

**Recommended Texts**
**Aims**

This module introduces the relatively modern mathematical areas of Game Theory, Choice Theory and Linear Programming, and the relationships between them. The theory and techniques of each area is developed, and applications of them to economics, business and politics are explored. The core of both modules is the same, but the level 7 version will extend the topics taught in the level 6 version via extra lectures and higher level assessments.

**Teaching and Assessment**

Teaching for this module will take place throughout the year. There will be revision and consolidation lectures in the Summer Term. The level 6 version has 18 evenings, including two revision evenings in the summer term. The level 7 version will have the 18 evenings shared with level 6 students, and an additional 4-6 evenings over the year, meaning 22-24 evenings in total.

Of the final course mark, 80% is based on an examination in the summer term and the other 20% is from assessed coursework. The level 7 exam will be 3.5 hours, the level 6 exam will be 3 hours; they'll be on the same day.

Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

**Syllabus**

- **Linear Programming**
  
  Expressing a problem using a linear programme, graphical methods, the simplex algorithm, duality, sensitivity analysis.

- **Individual Choice**
  
  Menus, reflexivity, completeness, transitivity, utility functions, continuity, rationality, choice under uncertainty.

- **Social Choice**
  
  Social choice procedures, plurality, the Hare system, the Borda count, sequential pairwise voting, approval voting, dictatorships, Pareto condition, Condorcet's criterion, monotonicity, independence of irrelevant alternatives, social welfare functions, Arrow type theorems.

- **Static Games**
  
  Matrix form, movement diagrams, saddle points, mixed strategies, zero-sum games, graphical methods for solving games with one player having two strategies, von Neumann's minimax theorem, using linear programming to find the solution of a game, nonzero-sum games, the prisoner's dilemma, chicken, battle-of-the-sexes, Nash's theorem and Nash equilibria, Pareto optimality, graphical representation of a two player game.

- **Dynamic Games**
  
  Game trees, backwards induction, imperfect information, patent races, bank runs, the Leontieff wage-labour negotiations, the duopoly problem–classical model, Cournot model, Stackelberg model, collaboration and side payments.

- **Voting Games**
  
  Proper and strong games, monotonicity, weighted games, weighted games, swap-robustness, trade-robustness, power indices, bloc voting, qualified majority voting in the EU Council of Ministers.
Mathematics of Communications (BUEM038H7)

15 credits, level 7

Aims
The mathematics of communications module aims to introduce students to the mathematics underlying various aspects of communications technology, including coding theory and cryptography. It will give students an introduction to various communications applications and equip them with the mathematical background necessary for further exploration of these fields.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem-based assignments. You will have around three weeks to complete each one.

Syllabus
- **Information Theory**
  Uncertainty; Shannon entropy; conditional entropy; Shannon information; Shannon’s source coding theorem; Huffman coding; data compression.
- **Error Correcting Codes**
  The binary symmetric channel; Hamming distance; Shannon's noisy coding theorem; codes; bounds on the sizes of codes; linear codes; syndrome decoding; binary codes; Reed-Solomon codes.
- **Cryptography and Information Security**
  A range of topics will be covered including several from the following list: Perfect secrecy; the one-time pad; linear feedback shift registers; introduction to public-key cryptography; hash functions; secure pseudo-random number generation; secret-sharing schemes and perfectly secure message transmission.

Recommended Texts
Informal description of Mathematical and Numerical Methods (Lecturer: Brad Baxter)

The formal description of this course is rather dry, so I have decided to provide an informal description. The primary aim of the first half of the course is to understand Brownian motion and its uses (and abuses!) in mathematical finance. Extensive notes are available on my office server together with past examination papers and solutions. The course is really a classical applied mathematics methods course, but with the primary applications being mostly financial (but not merely financial: the same mathematics occurs in an atomic bomb, and I will not be able to resist description). The partial differential equations (PDEs) studied include the diffusion equation, the Black--Scholes equation, and the reaction--diffusion equation, and we shall also consider finite difference algorithms for their numerical solution in depth, as well as their solution via Fourier analysis. The course also contains much relevant numerical linear algebra, so should be of interest to students attracted by the study of algorithms.

Teaching and Assessment
Teaching will take place in both the Autumn and Spring Terms, over 20 weeks. Assessment is via coursework (20%) and a three-hour examination in June (80%).

Syllabus
a) Stochastic Processes for Finance
- To understand the basic concepts of stochastic calculus, in particular Brownian motion and stochastic integrals.
- To understand Ito calculus and its applications to stochastic differential equations (SDEs).
- To understand the numerical solution of an SDE
- To appreciate the connections between probability theory and partial differential equations via the Feynman-Kac formula.

b) Theoretical Numerical Methods for Finance
- To solve SDEs using Monte Carlo simulation.
- To understand the fundamental algorithms for the numerical solution of parabolic partial differential equations (PDEs).
- To understand the binomial method for option pricing as a finite difference method, particularly its disadvantages.
- To appreciate the importance of stability in numerical algorithms for PDEs.
- To understand numerical methods for the solution of nonlinear equations and some basic optimisation techniques.
- To know the basics of relevant numerical methods, eg data fitting.
- To illustrate the above by examples and exercises in MATLAB.

Recommended Texts
The courses will be based on fairly extensive lecture notes. For more detail on the course, including past exam papers, see econ109.econ.bbk.ac.uk/brad/Methods.
Mathematics Dissertation (BUEM039D7)

60 credits, level 7

Aims
- To give students the opportunity of undertaking a sustained, independent investigation into a specific topic in mathematics, related to one or more of the areas studied in the MSc programme, such as algebra or combinatorics.
- To give students practice in academic research, writing up and presenting the results and conclusions of an investigation in a report where the problem, final results and conclusions can be understood and appreciated by a mathematics graduate, and which includes sufficient technical detail for the proofs and arguments to be verified by a specialist in the field.
- To give students practice in the oral presentation of the background, results and conclusions of an investigation in a way that may be understood by mathematics graduate who has not necessarily specialised in the topic being studied.

Structure
The dissertation gives students the opportunity to identify and, with some guidance, carry out a research project in an area of mathematics related to one or more topics encountered on the MSc programme. Completely new work (such as the discovery and proof of a previously unknown theorem) would be very unusual at this level, however application of known results in different areas, or synthesis of existing academic research to produce a coherent analysis of a particular problem, would be acceptable kinds of project. During the first year there will be opportunities to learn about software for typesetting mathematics, and some guidance on choosing a research area. Each student is required to submit a project proposal at the beginning of the second year of study and a supervisor is then allocated. Once project and supervisor are agreed, and an initial meeting has taken place, students are expected, over the remainder of the autumn term, to complete:

(i) background reading on the project area and on the mathematical theory and techniques required,
(ii) assembling relevant books and journal papers, and locating and becoming familiar with any necessary software , and
(iii) final specification of the questions that are of interest and can feasibly be investigated in the time.

At the end of the autumn term in the second year, each student is required to give a 10 minute oral presentation, giving the relevant background to their project, the problem to be investigated, and progress to date. A written progress report is required by the end of the Spring term and the final project report of between 6,000 and 10,000 words must be submitted by September 1st at the end of the two years of study. Individual oral presentations of 25 to 30 minutes, including 5 minutes for questions, are then scheduled to be completed by mid to late September. Throughout the duration of the project, students are advised to discuss progress and obtain feedback from their supervisor on three/four occasions after the initial meeting, including feedback on the preliminary project presentation, the written progress report, and a draft plan and at most one draft section of the final project report.

Assessment
80% of the marks for the module are for the dissertation (submitted at the end of Year 2). 5% are for the initial ten minute oral presentation (Autumn Term Year 2), 5% for the written progress report (Spring Term Year 2) and 10% for the final oral presentation (End of Year 2).
**Number Theory and Geometry (EMMS093S6)**

30 credits, level 6

**Aims**

This is a two-part course aiming to provide you with an introduction to two important areas of pure mathematics, number theory and geometry -- topics which every pure mathematician will find of interest. The number theory section will cover types of numbers such as polygonal numbers and perfect numbers, followed by number theoretic functions, including Euler's $\phi$ function. We will prove Fermat's little theorem and study quadratic congruences as well as Pythagorean triples and sums of squares. The section on geometry will devote time to vector geometry, affine geometry and Euclidean geometry. Curves arising from conic sections, such as the ellipse and the hyperbola, will also be studied and their properties derived from first principles, with some applications and generalisations. Finally there will be a look at the geometry of the complex plane.

**Teaching and Assessment**

Teaching for this module will take place throughout the year, with eight evenings in each of the Autumn and Spring Terms and two evenings of revision and consolidation in the Summer Term. Of the final course mark, 80% is based on a three-hour exam in June and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each assignment. The examination in the Summer Term has three sections. Section A (worth 40%) consists of compulsory short questions. Sections B and C (worth 20% each) contain several longer questions. You must answer one from Section B and one from Section C.

**Syllabus**

**Number Theory**

- Numbers with names: polygonal numbers, Fermat primes, Mersenne primes, perfect numbers.
- Number theoretic functions, including Euler's $\phi$ function.
- Fermat's little theorem and applications to public-key cryptography.
- Quadratic Congruences. Pythagorean triples and sums of squares.

**Geometry**

- Vectors; affine transformations; dot products; Euclidean geometry; some basic theorems.
- Conics: Circles, parabolas, ellipses, hyperbolas; equations of conics; properties of conics; applications; generalisations.
- Geometry in the Complex Plane: Lines and Circles; the extended complex plane; Möbius transformations.

**Recommended Texts**

Pricing (EMMS014S7)

30 credits, level 6

Aims

To understand and be able to implement contingent claims (plain-vanilla and complex options in particular) and bond and other interest rate derivatives pricing by a variety of approaches: binomial, PDE and martingale pricing methods.

To understand and be able to implement contingent claims (plain-vanilla and complex options in particular) and bond and other interest rate derivatives pricing by a variety of approaches: binomial, PDE and martingale pricing methods.

Objectives

- To develop problem-solving abilities to value derivative securities.
- To become acquainted with standard derivative and bond pricing models.
- To understand equivalent martingale measures and their role in option pricing.
- To understand valuation techniques based on change of numeraire.
- To understand the concepts of complete and incomplete markets.
- To apply the martingale approach to a variety of contexts: option pricing, term structure models for both defaultable and non-defaultable bonds.
- To understand the main types of single-name and structured credit derivatives and their pricing methodology, including its weaknesses.

Assessment

• Assessment: coursework counts for 20% and a three-hour examination in June for 80%

Recommended Texts

The courses will be based on fairly extensive lecture notes. Detailed reading lists will be provided during term.
Reflection Groups (BUEM065H7)

15 credits, level 7

Aims
The aim of the module is to introduce the topic of reflection groups, which brings together geometry, linear algebra and groups in a beautiful theory with its roots in classical mathematics but with many applications in current research. It will give you a chance to study in depth a slightly more specialised area than the companion, more general group theory module which runs in the alternate year to this one. The modules are independent in content however, and you can take both, one or neither as options, in any order.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination.

Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

Syllabus
- Geometric context: revision of required Euclidean geometry; symmetry groups, examples of reflection groups.
- Root systems; positive and simple/fundamental roots, simple/fundamental reflections as generators, the length function.
- Parabolic subgroups, and examples
- Classification of finite reflection groups: Coxeter graphs, isomorphisms and subgraphs, crystallographic groups.
- Coxeter groups: examples, relationship to reflection groups, special cases.

Recommended Texts
- Reflection Groups and Coxeter Groups
  (J. Humphreys, Cambridge University Press ISBN 0521 43613 3)
- Finite Reflection Groups
  (L. Grove, C. Benson, Springer, ISBN 0387 96082 1)
Representation Theory (BUEM060H7)

15 credits, level 7

Aims
This will be a 15 credit course introducing the important topic of representation theory. The students are assumed to have no background in representation theory, but should be comfortable with undergraduate group theory and linear algebra. After taking this module the student should have a good understanding of the basics of representation theory and should be able to engage with more advanced topics in the area.

Teaching and Assessment
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

Syllabus
A range of topics on representation theory will be discussed, including topics from the following indicative list:

- a brief review of vector spaces and linear transformations,
- group representations, modules, and group algebras,
- Maschke's theorem,
- Schur's Lemma,
- irreducible and reducible modules,
- characters and inner products,
- restriction and induction,
- tensor products and representations.

We will apply these concepts to study the representation theory of some specific groups, such as symmetric groups and other finite groups.

Recommended Texts

**Topics in Graph Theory (BUEM035H7)**

15 credits, level 7

**Aims**
This module aims to provide an advanced course in Graph Theory for the MSc programme in Mathematics. Together with the modules *Topics in Combinatorics* and *Discrete Optimization*, a detailed coverage of the accessible, yet demanding, area of combinatorial mathematics is provided.

**Teaching and Assessment**
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem-based assignments. You will have around three weeks to complete each one.

**Syllabus**
To allow for current developments in the subject, and the individual interests and expertise of the lecturer, the module covers the section on Introductory Concepts, together with around five of the other topics listed.

- **Introductory Concepts**: simple graphs, degree of a vertex, paths and cycles, connectivity, trees, bipartite graphs, Eulerian and Hamiltonian graphs.
- **Connectivity**: 2-connected graphs and their subgraphs, the structure of 3-connected graphs, Menger’s Theorem, linked and k-linked sets of vertices in a graph.
- **Planar Graphs**: embeddings of a planar graph, Kuratowski’s Theorem, algebraic criteria for planarity, duality.
- **Colouring**: vertex colouring, edge colouring, Brook’s Theorem, Vizing’s Theorem, the four colour theorem, chromatic polynomials.
- **Extremal Graph Theory**: minors of a graph, Hadwiger’s conjecture, Turan’s Theorem, Ore’s Theorem, Szemerédi’s Regularity Lemma and its applications.
- **Infinite Graphs**: paths, trees and ends, connectivity and matchings, Eulerian and Hamiltonian infinite graphs.
- **Random Graphs**: the notion of a random graph, the probabilistic method, properties of almost all graphs.
- **Graph Reconstruction**: vertex and edge deleted subgraphs, reconstruction conjecture, Kelly’s Lemma, recognizable classes of graphs, reconstruction of certain properties and parameters of a graph, edge reconstruction.
- **Algebraic Graph Theory**: matrices associated with a graph, eigenvalues of a graph, strongly regular graphs, the automorphism group of a graph.

**Recommended Texts**

**Topology (BUEM061H7)**

15 credits, level 7

**Aims**
This module aims to introduce students to the basic concepts of Point-Set Topology and Algebraic Topology including topological spaces and their invariants as well the Fundamental Group and its higher dimensional analogues. In particular the students will know by the end of the course how to determine if a topological space has basic topological invariants such as connectedness and compactness as well as how to compute fundamental groups. The course is stand alone but will also provide a grounding for those wanting to pursue research into many aspects of Topology.

**Teaching and Assessment**
Teaching for this module will comprise ten evenings of lectures in either the Autumn or Spring Terms, plus one evening of revision and consolidation in the Summer Term, before the examination. Of the final course mark, 80% is based on a three-hour exam in the Summer Term and the other 20% is from assessed coursework. Coursework will consist of short, problem based assignments. You will have around three weeks to complete each one.

**Syllabus**
- Definition and examples including the Euclidean, discrete and indiscrete topologies.
- Continuity, homeomorphisms and topological invariants.
- Path connected and connected spaces. Compact spaces and the Heine-Borel theorem.
- Products and Quotients. Tychonov's theorem for finite products.
- Homotopy of continuous functions and homotopy equivalence between topological spaces. Simply-connected spaces.
- The fundamental group of a space, homomorphisms induced by maps of spaces, change of base point, invariance under homotopy equivalence.
- Covering spaces and Deck transformations. Brief discussion of higher dimensional analogues such as homology and homotopy groups.

**Recommended Texts**
Aims
The aim of this module is to provide training in the mathematical typesetting package LaTeX for students on the MSc Mathematics. This package is universally used by research mathematicians, and mathematics journals, and so it is an essential tool for any postgraduate mathematician to acquire. After taking this module, students will be familiar enough with the package to produce dissertations, powerpoint-style presentations, articles and other documents.

Teaching and Assessment
Birkbeck students come from a very diverse range of backgrounds. Some have very little experience of computing, and may only really have used email, while others have years of training as programmers. It is therefore impractical to try to teach this course with a standard set of lectures or classes. For this reason, the module will be largely completed via self-study, with one or two introductory sessions followed up by regular timetabled slots in the computer room where tutorial support will be provided. You will be informed when these will be. Assessment is 100% coursework. You will be given four worksheets to complete at your own pace; at the end of each one you will submit an assignment. The final mark for the module is the mean average of the marks for the four worksheets.

Syllabus
- Understanding the process: knowing what LaTeX actually does and how to produce a readable output; producing a very simple document with basic text (assessed by worksheet 1)
- Writing mathematics: how to write equations, arrays, matrices and include symbols such as Greek letters, the symbols for the sets of integers, rational numbers and so on, integrals, sums and products (assessed by worksheets 1 and 2)
- Producing lists and tables (assessed by worksheets 1 and 2)
- Importing graphics (assessed by worksheet 2)
- Producing presentations – creating slides, gradual reveal and other effects (assessed by worksheet 3)
- Producing dissertations: title pages, chapters, tables of contents, references (assessed by worksheet 4)

Recommended Texts
You will be provided with worksheets to guide you through the process of learning LaTeX. For further resources, there is a wealth of information and support at ctan.org. We use the package ProTeXt, which you may download freely online, or if you prefer we can give you a CD with everything you require to install LaTeX on your own computer.
Assessment

Mathematics and Statistics Coursework

Our coursework policy may be updated from time to time. The latest version is always available at http://www.ems.bbk.ac.uk/for_students/msc_maths.

Coursework is a key component within all of our programmes. It provides the opportunity for students to assist their learning through the feedback provided by marked assignment scripts, as well as taking away some of the pressure from the written examinations in the summer. We also consider it important that you should be encouraged to manage time properly during your busy time at Birkbeck: it is our experience that those who do, are the ones likely to benefit the most from our programmes, and pick up the best marks!

To help support you in these desired aims and objectives, we have put in place an official policy on how items of coursework are to be dealt with. (The rules covering late submission of work are governed by the College-wide coursework policy.) This policy primarily covers assignments: however, other items of coursework are treated in a similar way.

- You will be allowed a minimum of 3 weeks to complete each assignment.
- Every assignment will be placed on the web as well as being distributed in lectures.
- Where possible we will return work within 4 weeks of the submission date. If this cannot be done, we will give notice of the likely return date either by email or via the webpage associated with the module or programme.

Submission and Receipt of Coursework

- Coursework should be neatly written or typed in black or blue ink on A4 paper.
- You should submit your work by placing it inside the Assignment Box (which is opposite the main lifts on the 7th floor).
- Plastic documents wallets, folders, etc. are non-returnable.
- The Assignment Box will be emptied in the morning and any assignment scripts found there will be stamped with the date of the previous working day.
- You can to check that your work has been received by looking your name up on a list (on the noticeboard opposite the lift on the seventh floor). It is your responsibility to check that submission has been acknowledged; lists are displayed on the noticeboard day after the deadline date.
- If you cannot deliver the assignment personally, then you can, at your own risk, either arrange for somebody else to do it for you, or have it sent in by post. Note that irrespective of the date of posting, the date of arrival will be deemed to be the date of submission. Electronic submission of coursework (for e.g., via fax, or as an email attachment) is not acceptable and such submissions will not be considered eligible for examination.
- Only the first submission of an item of coursework will be considered. Later substitutes, or additions, to the original submission will not be accepted or considered for examination except by the invitation of the relevant examiner.
- You must keep a copy of your assignment for your records.
You are advised to have marked coursework returned to you in person only. Requests to have work left in the student pigeon hole must be made by email to the mathematics and statistics administrator; it is understood that work that is returned via the pigeon hole is done so at your own risk.

All marked coursework will need to be returned to the mathematics and statistics administrator during the summer term, for moderation by the visiting (external and/or intercollegiate) examiners. You will be contacted in writing and asked to return your marked coursework. After moderation you may collect coursework if you wish; any coursework not collected will be destroyed.

Late Submission

- If you submit work late (but not more than 14 days late), your mark will be capped at the pass mark for your programme (40% for undergraduate programmes, 50% for postgraduate programmes). That is, your work will be marked as normal and you will be told this mark, which is the ‘real’ mark that would have been awarded if the work had not been late. If the work is not of a pass standard this is the mark that will be awarded. However, if the work is of a pass standard, you will be given the capped pass mark of 40% or 50%.
  
  If there are mitigating circumstances you can request that the penalty be lifted. You must do this in writing by submitting a statement outlining the reasons for special consideration to be given, along with relevant supporting documentation (e.g. medical certificate, employer statement etc.) to your programme administrator. If the statement and documentation are all found to be in order, this will then be sent for consideration by a sub-committee meeting of the relevant (sub-)Board of Examiners (which normally takes place twice a year, in the Spring and Summer Terms). If no such documentation is received prior to the meeting the ‘real’ mark will not be considered and the penalty mark will stand.
- If the assignment is handed in late by more than 14 days, for whatever reason, then it cannot be considered for examination. If this is the case, or the assignment is not handed in at all, then the default position is that the assignment will be given a score of 0 (zero). If there is a case to be made for being awarded a ‘nominal substitute’ mark for an assignment falling into this category, then, as for submission up to 14 days late, you will need to put this case in writing for consideration.

Note: Any part of this policy may be suspended, or modified, on a case-by-case basis, in line with disability provision, upon advice from appropriate College authorities.

Revision and Exam technique

Studying for Examinations

- Little and often is better than 8 hour marathon sessions the night before the exam. Draw up a study timetable and stick to it.
- Be active. Don’t just read through the notes. Test yourself on definitions and theorems. Try out methods and theorems with your own examples.
- Use the syllabus and learning outcomes to get an idea what to emphasise in your revision.
- Learn all the definitions. Practise writing out definitions and results from memory until you are word perfect.
- Learn the statements of all theorems from lectures. Read the proofs and try to understand them. Learn the proofs, especially the short ones that you might be asked to reproduce.
- Practise by doing questions from lecture notes, questions in books, past exam questions (where available) or even make up questions! Because the mathematics and statistics programmes have been redesigned recently, some modules you take will be new, and have no past papers. If this is the case, lecturers will provide a sample exam paper to give you an
idea of the style and level of the exam. Where modules have run before, past papers are available on the Library website. Solutions to past exams are not automatically available as exam questions may sometimes be set as coursework in following years; however some lecturers do make solutions available on their websites.

- Make use of lecturers! Contact us as soon as possible if you are having difficulties. Make a list to take with you of the points which are causing you difficulty so you can tackle them one by one.

Exam Technique

- Arrive in good time and do your best to keep calm.
- Make sure you have read the rubric and know exactly how many questions you need to answer and which questions are compulsory.
- Look through the whole examination paper to size it up. Maybe the last question is exactly what you’ve just revised. Starting with a question you feel confident about can help you relax and do better in the rest of the exam.
- If marks are allocated for questions, this gives a guide as to how much time you should devote to them. Don’t spend 20 minutes trying to answer a 1 mark question.
- If you think there is an error on the exam paper, let an invigilator know as soon as possible. All exams are thoroughly checked by at least three people, but very occasionally mistakes happen. The invigilator will contact the examiner who can confirm whether or not there is an error and correct the question if appropriate.
- Write clearly and use as much space as you need. Explain what you are doing so you can get partial marks for a correct method even if the final answer is wrong.
- Number your questions carefully, especially if you come back and answer, say, 3(b) at the end of the exam, when 3(a) and (c) are in a completely different place in your answer book. Ideally you would write a little note to the examiner saying “for 3(b), see end of script”.
- Try and leave some time at the end to check over your answers and make sure you have attempted all the compulsory questions.

Registration for Examinations

Every year you will be emailed a computer link which you will need to access to confirm the modules you are taking. Once you have entered your ITS username and password the exams you are entered for will be listed. You need to check carefully that the information is correct, then confirm the modules online. This is essential because without this, you will not be allocated a Candidate Number. Later in the year you will be emailed an examination admission notice which you need to print off and bring with you to each exam, together with your Birkbeck student ID card, in order to gain admittance to the examination room. You will need to write your Candidate Number on your examination script. When examination results are issued (normally late July), you will be emailed, and you will then be able to go online to your “My Studies at Birkbeck” page to check your results. **You will not be sent a paper copy of your results; they will only be available online. Official transcripts of your results will be sent out by the Exams department on completion of your studies.**

Students can obtain transcripts from the exams department, before completion of studies, at a cost.

The examination timetable will be available in the spring. It is your responsibility to check the dates and times of your exams and make sure you are down for the correct exams and that there are no clashes. If you find you have a clash, you should inform the registry as soon as possible. If you are late for an exam you may not be permitted to take it, as people may already have left the exam room. So be on time!

You may attempt an examination a maximum of two times. Once you have confirmed your intention to study, then failure to take the exam, even if you subsequently withdraw from the module, this would
count as one of your attempts (unless you have mitigating circumstances, see below). Therefore it is very important to make sure you have correctly entered your choice of modules.

If you have to withdraw for some reason before the exam, you must inform Registry of this and get permission to withdraw. Simply not turning up on the day (unless you later provide a doctor’s note or similar to explain your absence) will count as one of your attempts at the examination.

Permission to defer the examination or any part of the examination, including submission of an essay, project, dissertation or other written work, may only be granted for reasons judged adequate in the particular case at the discretion of the College. Application for permission to defer examination(s) must be made in the case of summer examinations at least 14 days in advance of the first examination or by 1 May whichever is the earlier. You need to complete an application form (these can be obtained from the mathematics and statistics administrator). The form must then be given to the Programme Director of your degree programme. Such applications are granted or refused at the discretion of the Programme Director and you may be asked to submit documentary evidence in support of your application.

If you are unable to attend an exam due to illness or any other unforeseen reason you must complete a mitigating circumstances form at the earliest opportunity, and at the latest 7 days after the final examination for your programme for the year. If you submit this form after this time without good cause then your claim will not be considered. Degree Examination Boards may, at their discretion, set an absolute deadline after which no application for consideration of mitigating circumstances will be considered. Claims that do not include relevant information or documentary evidence will not be considered. All information submitted as a claim of mitigating circumstances will be treated as confidential.

Calculators
You will need a scientific calculator for examinations. It should have trigonometric functions (with degrees and radians), roots and powers, exponents, logarithms, factorials, combinations and permutations. A fraction key is also useful. You do not need a graphical calculator. Some people borrow calculators for exams. This is not a good idea because you will not be familiar with it and you shouldn’t waste time in exams learning how to work your calculator. The following calculators are approved for use in all undergraduate and MSc Mathematics examinations.

Casio calculators The following calculators are approved.

- Casio fx-83 GT Plus; Casio fx-83 ES; Casio fx-83 GT Scientific Calculator

Sharp calculators The following calculators are approved. As Sharp seem to produce a number of versions of essentially the same calculator, the word series is used to indicate any model with the preceding text at the start of its model name.

- Sharp EL–501 series; Sharp EL–511 series; Sharp EL–520 series; Sharp EL–531 series

Other Calculators
If you want to use any other calculator in the examinations then you must get it approved in advance. To do this, you need to fill in a calculator approval form and get it signed by the Chair of the MSc Mathematics Examinations Sub-board, currently Dr Amarpreet Rattan. Note: programmable calculators, graphical calculators and any calculator with a keyboard or capable of doing symbolic algebra will not be approved.

Plagiarism
Plagiarism is the presentation of another person’s ideas as if they were your own. It is a serious academic offence, and could result in marks for assessment being capped or the assessment being
failed. Students who plagiarise more than once could have their registration with the College terminated.

In all mathematics and statistics programmes you are required to complete assignments for most modules consisting of exercises to test your understanding of the material covered. Your answers for an assignment should be your own work. If you copy all, or part, of another student’s answers this would constitute plagiarism, and could result in you being awarded a mark of zero for the assignment. Note that it is also an offence to allow another student to copy your work.

For other types of assessment, such as your project dissertation, you will have to include details of other people’s work. When you do this it is important that you clearly reference the work, and give a detailed list of references, including information from websites, at the end of your work. If you do not do this then it counts as plagiarism and you are likely to fail the assessment.

Remember you should not plagiarise; it is a form of cheating. If you are in any doubt about what is permissible then you should consult your lecturer or programme director.

Reassessments and Retakes
The pass mark for modules on postgraduate programmes is 50%. Students are allowed up to two attempts at each module. An “attempt” occurs when a student registers for a module and does not subsequently formally withdraw from that module before the published deadline. Therefore failure to submit coursework by the deadline or failure to attend the examination without accepted mitigating circumstances will count as a failed attempt. If you fail a module on your first or second attempt one of two paths will normally be offered:

- **Reassessment** (in individual elements, such as exam only, or the whole module) means you will be assessed again on the failed element or elements, without having to attend lectures. The reassessment will not count towards the total number of modules taken in any one year – this is limited to 90 credits worth. It will either be at the next normal assessment opportunity (i.e. when the module is next taught) or before the start of the following academic year. Reassessment is not compulsory; you may choose to retake instead. You will be told the form and timing of the reassessment before you need to make the decision.

- **Retake** means that you will re-enrol on the module, attend lectures and retake all assessment associated with that module (both coursework and exam). The module will count as one of the total modules taken in any one year. This may mean that your programme will take longer to complete, as there is an upper limit on the number of modules you can take in one year.

There is currently no charge for reassessments.

The final result for a module will be obtained from the marks obtained in all elements (usually weighted at 20% for coursework and 80% for exam – this is specified in the individual module description). For any element of assessment taken more than once, the highest mark obtained will be used. You will be offered two attempts at passing any element, including a maximum of one reassessment opportunity. Note that you cannot retake or be reassessed on individual elements of a module if you have gained an overall pass in the module. If a module is no longer available you can agree a replacement module with the Programme Director.

**Any element of assessment that is submitted as a reassessment and for which no application for consideration of mitigating circumstances has been accepted will be awarded a mark of no more than 50%.** Where an application for consideration of mitigating circumstances is accepted, and a re-assessment awarded by the sub-board the work may be submitted without penalty and the
reassessment will not be capped at the pass mark.

Module marks will appear on your MyBirkbeck Profile, along with a record of how many times each module has been attempted. You may see a code next to the mark – codes are defined at the bottom of the profile page, but the main ones to be aware of are F, FR and DR. The code F means you have failed the module by some margin and so will not be offered a reassessment opportunity – if you want to attempt the module again you will have to retake it the next time it runs. The code FR means you have failed the module, but will have the option to be reassessed. If the FR is against your exam mark, this means you will be reassessed in the exam. If the FR is against the coursework mark, this means you will be reassessed in the coursework (normally just one coursework, covering all assignments). Technical point: when a mark appears as FR, the system assumes until told otherwise that you will accept the offer to do a reassessment, so adds 1 to the number of attempts in preparation for the reassessment mark to be inputted. So if you failed your first exam attempt with 33%, you would see 33 FR, and 2 attempts recorded, the second one being the reassessment. If you turn down the chance at a reassessment the code will change to F, and 1 attempt will be recorded.

The code DR will appear if a mitigating circumstances claim you submitted was accepted and you are being offered a reassessment. What you are offered a reassessment in will again depend on what this code is displayed against. Other codes you may see are P (pass), W (withdrawn) and NS (no show at exam).

**Pass Requirements and Award Classification**

This section describes the pass requirements and method of calculation of final overall marks for the MSc Mathematics. Please note that these are the regulations at the time of going to press. However, the college reserves the right to alter existing schemes, without notice, on the advice of the External examiners or otherwise and with the approval of the appropriate College authority.

Full examination and assessment regulations are available on the Birkbeck student intranet at .

To gain the MSc Mathematics you must pass modules to the value of 180 credits at level 6 or 7 from the modules available on your programme. At least 150 credits of these must be at level 7.

Your result will be the mean average mark from **all the level 7 modules** you have taken (level 6 modules are not included in the calculation, but marks for them are shown on your transcript). From this figure the award is classified as follows:

- **Pass**: 50% or above, but less than 60%;
- **Merit**: 60% or above, but less than 70%;
- **Distinction**: 70% or above.

**Postgraduate Certificate and Diploma Awards**

If for whatever reason you are unable to complete the whole MSc programme, you may be able to obtain either a postgraduate certificate (PGCert) or postgraduate diploma (PGDip) in Mathematics.

To gain the postgraduate certificate in Mathematics, you must have passed modules to the value of 60 credits at level 7. Thus any level 6 modules taken would not be able to count towards this total.

To gain the postgraduate diploma in Mathematics, you must have passed modules to the value of 120 credits at level 6 or 7, of which at least 90 credits must be at level 7. So this could be awarded for completing just the taught component of the MSc, without the dissertation.
For both the PG Cert and PG Dip the award is classified as with the MSc. So the result is the mean average of all the level 7 modules taken. From this figure the award is classified as follows:

- **Pass**: 50% or above, but less than 60%;
- **Merit**: 60% or above, but less than 70%;
- **Distinction**: 70% or above.

**Postgraduate Certificate and Diploma Awards**

If for whatever reason you are unable to complete the whole MSc programme, you may be able to obtain either a postgraduate certificate (PGCert) or postgraduate diploma (PGDip) in Mathematics.

To gain the postgraduate certificate in Mathematics, you must have passed modules to the value of 60 credits at level 7. Thus any level 6 modules taken would not be able to count towards this total.

To gain the postgraduate diploma in Mathematics, you must have passed modules to the value of 120 credits at level 6 or 7, of which at least 90 credits must be at level 7. So this could be awarded for completing just the taught component of the MSc, without the dissertation.

For both the PG Cert and PG Dip the award is classified as with the MSc. So the result is the mean average of all the level 7 modules taken. From this figure the award is classified as follows:

- **Pass**: 50% or above, but less than 60%;
- **Merit**: 60% or above, but less than 70%;
- **Distinction**: 70% or above.
# Quick Reference

## Useful Contacts

### Contacts in Economics, Mathematics and Statistics

<table>
<thead>
<tr>
<th>Name</th>
<th>Room</th>
<th>Telephone</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Office</td>
<td>717</td>
<td>020 7631-6442</td>
<td>-</td>
</tr>
<tr>
<td>School Fax</td>
<td>717</td>
<td>020 7631-6416</td>
<td>-</td>
</tr>
<tr>
<td>Cassie Fernandes</td>
<td>717</td>
<td>020 7631-6442</td>
<td><a href="mailto:c.fernandes@bbk.ac.uk">c.fernandes@bbk.ac.uk</a></td>
</tr>
<tr>
<td>(MSc, BSc Maths/Stats administrator)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles Graham</td>
<td>717</td>
<td>020 7631-</td>
<td><a href="mailto:c.graham-dixon@bbk.ac.uk">c.graham-dixon@bbk.ac.uk</a></td>
</tr>
<tr>
<td>(Grad cert/dip Maths/Stats administrator)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yunus Aksoy</td>
<td>732</td>
<td>020 7631-6407</td>
<td><a href="mailto:y.aksoy@bbk.ac.uk">y.aksoy@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Brad Baxter</td>
<td>755</td>
<td>020 7631-6453</td>
<td><a href="mailto:b.baxter@bbk.ac.uk">b.baxter@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Andrew Bowler</td>
<td>751</td>
<td>020 7631-6443</td>
<td><a href="mailto:a.bowler@bbk.ac.uk">a.bowler@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Anthony Brooms</td>
<td>750</td>
<td>020 7631-6439</td>
<td><a href="mailto:a.brooms@bbk.ac.uk">a.brooms@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Ben Fairbairn</td>
<td>754</td>
<td>-</td>
<td><a href="mailto:b.fairbairn@bbk.ac.uk">b.fairbairn@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Isabella Gollini</td>
<td>738</td>
<td></td>
<td><a href="mailto:i.gollini@bbk.ac.uk">i.gollini@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Sarah Hart</td>
<td>753</td>
<td>020 7631-6437</td>
<td></td>
</tr>
<tr>
<td>Kenjiro Hori</td>
<td>728</td>
<td>020 7631-6424</td>
<td><a href="mailto:k.hori@bbk.ac.uk">k.hori@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Simon Hubbert</td>
<td>756</td>
<td>020 7631-6404</td>
<td></td>
</tr>
<tr>
<td>Steven Noble</td>
<td>728</td>
<td>020 7631-6424</td>
<td><a href="mailto:s.noble@bbk.ac.uk">s.noble@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Georgios Papageorgiou</td>
<td>735</td>
<td>020 7631-6410</td>
<td><a href="mailto:g.papageorgiou@bbk.ac.uk">g.papageorgiou@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Maura Paterson</td>
<td>748</td>
<td>020 7631-6440</td>
<td><a href="mailto:m.paterson@bbk.ac.uk">m.paterson@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Rosalba Radice</td>
<td>731</td>
<td>020 7631-6795</td>
<td></td>
</tr>
<tr>
<td>Amarpreet Rattan</td>
<td>734</td>
<td>020 7631-6576</td>
<td><a href="mailto:a.rattan@bbk.ac.uk">a.rattan@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Emanuela Sciubba</td>
<td>727</td>
<td>020 7631-6450</td>
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<tr>
<td>Anne Sibert</td>
<td>733</td>
<td>020 7631-6420</td>
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<tr>
<td>Martin Sola</td>
<td>731</td>
<td>020 7631-6411</td>
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<tr>
<td>Roald Versteeg</td>
<td>752</td>
<td>020 7631-6451</td>
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<tr>
<td>Stephen Wright</td>
<td>701</td>
<td>020 7631-6448</td>
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<tr>
<td>Jing Xu</td>
<td>732</td>
<td>020 7631-6427</td>
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</tr>
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</table>

### Birkbeck Administrative Contacts

<table>
<thead>
<tr>
<th>Name</th>
<th>Telephone</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>My Birkbeck Helpdesk</td>
<td>0845 601 0174</td>
<td><a href="mailto:info@bbk.ac.uk">info@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Birkbeck Switchboard</td>
<td>020 7631-6000</td>
<td></td>
</tr>
<tr>
<td>ITS Helpdesk</td>
<td>020 7631-6543</td>
<td><a href="mailto:ITS-helpdesk@bbk.ac.uk">ITS-helpdesk@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Disability Office</td>
<td>020 7631-6315</td>
<td><a href="mailto:disability@bbk.ac.uk">disability@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Library Enquiries</td>
<td>020 7631-6063</td>
<td><a href="mailto:library-help@bbk.ac.uk">library-help@bbk.ac.uk</a></td>
</tr>
<tr>
<td>Students’ Union</td>
<td>020 7631-6335</td>
<td></td>
</tr>
<tr>
<td>SU Advice Centre</td>
<td>020 7631-6335</td>
<td><a href="mailto:advice@bcsu.bbk.ac.uk">advice@bcsu.bbk.ac.uk</a></td>
</tr>
</tbody>
</table>

### Security

In an emergency, dial 555 from any phone in college. When you arrive for a lecture take a moment to familiarise yourself with the fire exits. If there should be a fire alarm during a lecture or at any time when you are on the premises, leave the building by the nearest fire exit and get well away from the building until you are told it is safe to go back in. Do not stop to collect up all your belongings.
Term Dates

Term dates and holiday closing for 2016/2017

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<td>Autumn</td>
<td>Monday 3 October 2016-Friday 16 December 2016</td>
<td>College will close at 6pm on 22 December, and normal services will resume from 9am on 3 January.</td>
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<td>Christmas and New Year closure</td>
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<td>Spring</td>
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<td>College will close at 6pm on 12 April, and normal services will resume from 9am on 19 April.</td>
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<td>Summer</td>
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The Greek Alphabet

Letters from the Greek alphabet are often used in mathematics, so for reference here it is.

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