MATH1081 Discrete Mathematics

INFORMATION BOOKLET

Semester 1 2013
# Contents

**General Information**
- Contacting the Student Services Office ........................................... 3
- Lectures .............................................................................................. 3
- Tutorials .............................................................................................. 4
- Assessment .......................................................................................... 5
- Calculator Information ......................................................................... 8
- Illness and other problems ................................................................... 9
- School of Mathematics and Statistics Policies ...................................... 10

**Conditions for special consideration** .............................................. 11

**University statement on plagiarism** ............................................... 13

**Syllabus** ............................................................................................ 14

**Problem sets** ...................................................................................... 16
- Problem set 1 ....................................................................................... 16
- Problem set 2 ....................................................................................... 22
- Problem set 3 ....................................................................................... 27
- Problem set 4 ....................................................................................... 37
- Problem set 5 ....................................................................................... 43

**Answers to selected problems** ......................................................... 54

**Examples of past class tests** ............................................................. 64
GENERAL INFORMATION
Semester 1, 2013

Assumed Knowledge and Co-requisites
MATH1081, Discrete Mathematics, is a first year 6UOC course offered by the School of Mathematics and Statistics in semester 1 and semester 2. The assumed knowledge for the course is the equivalent of a combined mark of at least 100 in HSC Mathematics and HSC Mathematics Extension 1. However, because a certain mathematical maturity is desirable for successful study of the course there is a formal corequisite of MATH1131 or MATH1141 or MATH1151.

The nature of the course
The subject matter of this course is very different from “high school mathematics” and success at high school is no guarantee of success in Discrete Mathematics. In MATH1081 emphasis is placed on reasoned argument and clarity of exposition as well as algebraic and computational skills. To maximize your understanding of new ideas, make full use of your lectures and tutorials by reading appropriate sections of the text books and try working through the suggested problems. Ask at tutorials for assistance with problems that you have had difficulty in solving; get your tutor to clarify concepts you have not understood. If you make the effort and understand the ideas in this course, you will benefit enormously in all your future mathematics and computing courses.

Aims
The aim of MATH1081 is that by the time you finish the course you should understand the concepts and techniques covered by the syllabus and have developed skills in applying these concepts and techniques to the solution of appropriate problems. Successful completion of the course will give you a good foundation for understanding many problems that arise in computer science.

Learning Outcomes
A student should be able to:

• state definitions as specified in the syllabus,
• state and prove appropriate theorems,
• explain how a theorem applies to specific examples,
• apply the concepts and techniques of the syllabus to solve appropriate problems,
• understand and apply appropriate algorithms,
• use mathematical and other terminology appropriately to communicate information and understanding.
Contacting the Student Services Office

The School of Mathematics and Statistics web-site

http://www.maths.unsw.edu.au

contains many pages of useful information on mathematics courses, school policies and how to obtain help, both academic and administrative.

In particular, the URL

http://maths.unsw.edu.au/currentstudents/student-services

provides a range of menus to choose from.

If you cannot find the answer to your queries on the web pages you are welcome to contact the First Year office directly.

The student administration officer for First Year in the Student Services Office of the School of Mathematics and Statistics is Ms F. Fan (Francy). All administrative enquiries concerning first year Mathematics courses should be sent to Ms Fan, either:

- by email to fy.MathsStats@unsw.edu.au
- by phone to 9385 7011
- or in person in room RC-3090.

Change of tutorials, due to timetable clashes or work commitments, permission to take class tests outside your scheduled tutorial, advice on course selection and other administrative matters are handled in the Student Services Office. Constructive comments on course improvement may also be emailed to the Student Services Office. Should we need to contact you, we will use your official UNSW email address of

zSTUDENTNO@student.unsw.edu.au

in the first instance.

Lecturers

Dr Dennis Trenerry
Dr David Angell, RC-3093

Lecturer in Charge

Dr. David Angell RC-3093

Lectures

Lectures are given four times per week, commencing in week 1 and running to week 12. Full details of the timetable are shown in your timetable on myUNSW and the Online Handbook.

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
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<tbody>
<tr>
<td>Semester 1</td>
<td>11-12</td>
<td>5-6</td>
<td>3-4</td>
<td>9-10</td>
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<td></td>
<td>Mathews B</td>
<td>Mathews B</td>
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<td>Mathews B</td>
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</table>

The material presented is divided into five sections, and each part will be presented in 2 or 3 week segments as follows:
In semester 1 Dr. Trenerry will lecture on sections 1, 2 and 5 and Dr. Angell will lecture on sections 3 and 4.

Tutorials

Each student enrolled in MATH1081 has chosen or been assigned to two tutorial time slots. If you wish to change your tutorial times, you should try to do this online using myUNSW before the Monday of week 2. After that time you will not be able to make tutorial changes online. Instead, you will have to go to the Student Services Office, RC-3090. Note that normally the Student Services Office will only change a tutorial time for you if the allocated time clashes with another course. **You can NOT arrange a change of tutorial by speaking to your tutor, you MUST do it through the Student Services Office.**

Each student will have two tutorials per week with the same tutor, **with tutorials starting in week 2 and running to week 13.**

All students will have selected a pair of tutorial classes from the available tutorials times:

- **Group A** Mon 10-11, Thu 12-1 or
- **Group B** Mon 12-1, Thu 10-11 or
- **Group C** Wed 12-1, Fri 10-11 or
- **Group D** Mon 4-5, Thu 2-3

These times are compatible with standard first year patterns. If none of these pairs is suitable consult with the Student Services Office, Red Centre 3090.

Attendance at tutorials is compulsory and the roll will be called in tutorials.

To create tutorials of roughly even sizes, some tutorial classes may need to be closed, or opened, during week 1. If you are affected by any tutorial room changes you will be notified by email to your official UNSW email account

zSTUDENTNO@student.unsw.edu.au

During week 1 and 2, it is good practice to check your timetable regularly on myUNSW.

The main purpose of tutorials is to provide you with an opportunity to get help with any problems which you find difficult and any parts of the lectures or textbook which you don’t understand. In order to get real benefit from tutorials you should

- Study your lecture notes and attempt relevant problems **before** the tutorial so that you can find out the areas in which you have difficulties.
- Make sure that your tutor is aware of the areas in which you need help.
- Be as specific as possible in describing your difficulties — don’t just say “could you explain about set algebra”. Be an active participant in tutorials, asking and answering questions rather than just sitting and watching.

All the tests which you submit (except formal examination scripts) will be marked by your tutor and returned through tutorials. Tutors are expected to return class tests the week following the test, and are expected to enter the marks into the School’s database, for you to check, within a fortnight of the test.

Your tutors and lecturers will generally provide you with times when they are available to see students outside tutorial class time. However, from about week 3 of semester, there will be a roster of staff available to help students in first-year mathematics courses. This roster is displayed on level 3 of the Red Centre, on the notice boards adjacent to the Student Services Office and opposite the School Office (Room RC-3070).
UNSW Moodle

The School of Mathematics and Statistics uses the Learning Management System called Moodle. To log in to Moodle use your zID and zPass at the following URL:

http://moodle.telt.unsw.edu.au

Once logged in, you should see a link to MATH1081 that will take you to the MATH1081 homepage in Moodle.

In the general information section there is a link called “Maths & Stats marks”. This takes you to a page where you can log in with your zPass and see the marks recorded for various assessment tasks. After classes have finished and before the start of the exam period, you should log in here and check that your marks have been correctly recorded. This is also where you will find your provisional final mark once it is released by the School.

If you are unable to log in to Moodle or cannot access MATH1081 once logged in you should contact the IT Service Centre. Contact information is provided on the Moodle login page.

Textbooks


Reference Books


For interesting applications within Computer Science, try the three part classic - D.E. Knuth, “The Art of Computer Programming”.

Assessment

Assessment will be made up of two components - Final Examination 80% and Class Tests 20%. Questions to be included in the class tests will mainly be similar to some of the unstarred questions in the problem sets. Examination questions are by their nature different from short test questions. They may test a greater depth of understanding. The questions will be longer, and possibly more difficult, and sections of the course not covered in the class tests will be examined. As a guide, see the recent past exam papers, which are part of this Course Pack.

Please read carefully the document on Additional Assessment in Mathematics on page 11.

In MATH1081 this means that there will be an extra examination in July for those who demonstrate that they were too sick to attend the June examination. A student who is absent from the final examination due to ill health or other misadventure will NOT be granted additional assessment unless their performance in the class tests and their attendance at tutorials are satisfactory. **In order to be granted additional assessment students must have an average test score of at least 40%**.

Note that:

- You will **NOT** be allowed to take a calculator into class tests.

- Tutors are expected to enter test marks into the School’s database within a fortnight of the time of the test. Students can view their marks through the Student Portal, which is accessible via the “Maths & Stats marks” link on the MATH1081 homepage on UNSW Moodle.
It is your responsibility to check that these marks are correct and you should keep marked tests until the end of semester in case an error has been made in recording the marks. If there is an error, either speak to your tutor or bring your test paper to the Student Services Office as soon as possible but no later than no later than Friday week 13.

- Once the examinations section finalises the examination timetable, you will be able to find out the time and place of the MATH1081 examination from myUNSW. The web page


  has many useful links related to the running of UNSW examinations.

- Be aware that a final mark of 49 often means that the course has been failed. Therefore, it is very important that you attempt all tests.

- If your final mark is in the range 46-49 then you may be awarded the grade of “Pass Conceded” (PC) for the course. This decision is not made by the School of Mathematics and Statistics. The rules governing the granting of the grade of PC are on the web page


Class Tests

There will be one test for each of the first four sections outlined in the syllabus above. The best three will count for assessment. Tests for sections (1), (2), (3) and (4) will be held at the beginning of the first tutorial of the weeks given below.

  | section: (1) (2) (3) (4) | week:     4   6   9  12 |

Normal examination conditions apply in class tests. Students must provide their own A4 writing paper and a stapler to attach a cover sheet to their written work. It is compulsory for you to attend the test given at your allocated tutorial. Permission for you to take the test in a different tutorial can only be given by the Student Services Office. If you are too sick to attend a class test, do not make an application for Special Consideration. Simply give a copy of your medical certificate to your tutor and this will be taken into account when calculating your final mark. Delays due to transport problems or oversleeping will not be accepted as reasons for missing class tests. The marked tests will be returned at the tutorial one week after the test.
Note that

- You **MUST** be enrolled in a pair of tutorials and you **MUST TAKE EVERY TEST IN THE TUTORIAL TO WHICH YOU HAVE BEEN OFFICALLY ALLOCATED.**

- To each test you must bring
  - your **STUDENT ID** card
  - some blank A4 writing paper
  - a **STAPLER** (so that you can staple a cover sheet to your answers).

- Normal exam conditions apply in tests. In particular, during the test you must **NOT** have visible any material relevant to the test and you must not try to get assistance from (or give assistance to) any other person.

- You will **NOT** be allowed to use a calculator in class tests.

- When your test answers have been marked and handed back to you by your tutor, don’t try to change your answers or falsify the marks awarded — a student who tried to do this recently was penalised by being given a failure in the course.

- Your **best three scores** in the four tests will be counted towards your final assessment mark.

**Advice to Students**

Students are advised to take particular note of the detailed syllabus and notes provided later in this document.

The level of depth of understanding required in this course is best understood by considering the exercises, the sample class tests, and the past examination papers that are included in the MATH1081 Course Pack.

**Teaching Strategies**

MATH1081 is taught by carefully planned lectures that logically develop the concepts and techniques in the course. Examples are emphasised as they provide the motivation for the concepts and techniques of the course, and because students best understand the general theory when it is developed from simple, and then more complex, examples.

Small group tutorials allow students to apply the material introduced in the lectures. These tutorials provide the opportunity for individual assistance. Because the course is taught by topics, and not in two parallel strands, students have the same tutor for each tutorial. Students are expected to work conscientiously at understanding the solutions to the exercises and they are expected to bring their exercise booklets to tutorials.

Students are encouraged to give constructive feedback to teaching staff during the teaching semester. They are also encouraged to work collaboratively with other students in the course to develop their understanding and their problem solving skills.

**Statement on Assessment**

The School of Mathematics has responded to student and staff concerns about plagiarism. Consequently, all First Year Mathematics courses are assessed by randomly generated online tests, short class tests and a written examination. The short class tests provide regular feedback to students and allow the course to be broken into smaller segments to facilitate learning.

It is unusual for questions on class tests to be marked out of more than 3 or 4 marks, and advice is given to tutors as to how those marks are to be awarded. Generally part-marks are awarded according to the number of correct steps made in answering the question. Students should raise any concerns
that they have regarding their marks with their tutor when their papers are returned. If their concerns are not satisfactorily resolved, they may speak to the First Year Director.

Detailed marking schemes are prepared for the marking of the end of semester examination and check marking is generally used for quality assurance. Marks will only be changed if the mark is inconsistent with the marking scheme.

Details regarding the tests and examination are given later in this document.

Getting help outside tutorials

If you are having difficulty understanding the lectures or doing the suggested problems, always try to get help through your tutorials. In most cases there will be other students who are having the same difficulties and it is better to provide help to all at once rather than giving the same explanation to ten or twenty students individually outside class.

However, there may be occasions when there is not enough time to get your questions answered in a tutorial. In these cases you should be able to get some help outside tutorials. If your tutor is a full-time member of staff you can ask them for their room number and times when they are available to see students (many members of staff put a notice on their office door showing the times when they are available). Tutors who are not full-time members of staff are not required to be available outside tutorial class times and may not have offices in the School of Mathematics and Statistics. To cover students whose tutor is not available, from week 3 there is a roster which shows for each hour of the week a list of names of members of staff who are available at that time to help students in first year mathematics courses. This roster is displayed on the same noticeboard as timetables, near the School Office (Room 3070, Red Centre) and also outside the Student Services Office (Room 3090, Red Centre). It is also available from the web page

http://www.maths.unsw.edu.au/currentstudents/consultation-mathematics-staff

Calculator Information

For end of semester UNSW exams students must supply their own calculator. Only calculators on the UNSW list of approved calculators may be used in the end of semester exams. This list is similar to the list of calculators approved for HSC examinations.

BEFORE the exam period calculators must be given a UNSW “approved calculator” sticker, obtainable from the School of Mathematics and Statistics Office, and other student or Faculty centres.

The UNSW list of calculators approved for use in end of semester exams is available at


Interpretation of test results

The average mark for class tests in MATH1081 is between 6 and 7 out of 10. Past experience is that students are likely to have difficulty passing this course if their average test mark is less than 5. If you find that your average after the first two tests is less than 5, you should talk to your tutor about your situation and what you can do about it.

Further, past records indicate that about 65% of students whose best three class test marks totalled to 15 or less did not get an overall pass mark in MATH1081.

Graduate Attributes

MATH1081 will enhance your research, inquiry and analytical thinking abilities as it will provide you with the mathematical language and mathematical techniques to unravel many seemingly unrelated problems. The course will engage you in independent and reflective learning through your independent mastery of a wide range of tutorial problems. The mathematical problem solving skills that you will develop are generic problem solving skills, based on logical arguments and mathematical language,
that can be applied in multidisciplinary work. You will be encouraged to develop your communication skills through active participation in tutorials, and by writing clear, logical arguments when solving problems.

Academic misconduct

It is very important that you understand the University’s Rules for the conduct of Examinations and the penalties for Academic Misconduct. This information can be accessed through myUNSW at:


In recent years there have been cases where severe penalties have been imposed for misconduct in relation to tests and exams in Mathematics courses.

Illness and other problems

If your performance in this course is affected by illness or other serious difficulties which are beyond your control, you can apply for Special Consideration and you may be offered the opportunity for Additional Assessment.

In order to be offered Additional Assessment it is essential that you follow exactly the procedures set out in the sheet entitled “Application for Special Consideration in First Year Mathematics Courses 2013.” A copy of this document is included in this booklet. You should read it carefully now and keep it for reference at the time when you actually need it. Each year there are some students who fail a course because they didn’t follow these instructions. Take particular note that

- The School will NOT contact you to tell you that you have been granted Additional Assessment. It is YOUR RESPONSIBILITY to find this out by following the instructions in the document mentioned above.

- If you have a poor record of attendance or performance during the semester you may be failed regardless of illness or compassionate grounds affecting the final exam.

Note also that

- If illness affects your attendance at or performance in a class test, do NOT make an application for Special Consideration. Simply show a medical certificate to your tutor and this will be taken into account when calculating your final assessment mark.

- Transport delays and oversleeping will NOT be accepted as reasons for missing class tests. (But note that only your best three test results are counted for assessment.)

- If you arrive too late to be admitted to the end of semester exam, go immediately to the Student Services Office, Room 3090, Red Centre.

Information and handouts

Important announcements may be made in lectures. If you miss a lecture or tutorial, or arrive late for it, it is essential that you check whether you have missed any announcements or handouts. All important administrative announcements, especially those indicating a change to information contained in this booklet, are repeated as announcements on UNSW Moodle. Further, notices of an urgent nature may be emailed to students at their official UNSW email address.
School of Mathematics and Statistics Policies

The School of Mathematics and Statistics has adopted a number of policies relating to enrolment, attendance, assessment, plagiarism, cheating, special consideration etc. These are in addition to the policies of the University. Individual courses may also adopt other policies in addition to or replacing some of the School ones. These will be clearly notified in the Course Handout and on the Course Home Page on the MathsStats web site. Students in courses run by the School of Mathematics and Statistics should be aware of the School and Course policies by reading the appropriate pages on the MathsStats web site starting at:

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

The School of Mathematics and Statistics will assume that all its students have read and understood the School policies on the above pages and any individual course policies on the Course Handout and Course Home Page. Lack of knowledge about a policy will not be an excuse for failing to follow the procedures in it.

Getting advice

Your tutor should be able to give you most of the advice you need on mathematical and administrative matters concerning MATH1081. If your problems cannot be solved with your tutor, then please come to see me (Peter Brown) in RC-3073. I am happy to see you.

If you have general study problems or personal problems, don’t just hope that they will go away. Take advantage of the free and confidential help which is available within the university. The Learning Centre (on Level 2 of the Library) provides individual consultations and workshops on study skills, time management, stress management, English language, etc. The Counselling Service (2nd Floor, East Wing, Quadrangle Building) offers the opportunity to discuss any issue which concerns you including academic problems, personal relationships, administrative hassles, vocational uncertainty, sexual identity and financial hardship. For more details, see the Student Information web page, available from the home page of myUNSW.

Peter Brown
Director of First Year Studies
School of Mathematics and Statistics
fy.MathsStats@unsw.edu.au
APPLICATIONS FOR SPECIAL CONSIDERATION IN FIRST YEAR MATHEMATICS COURSES SEMESTER 1 2013

If you feel that your performance in, or attendance at, a final examination has been affected by illness or circumstances beyond your control, or if you missed the examination because of illness or other compelling reasons, you may apply for special consideration. Such an application may lead to the granting of additional assessment.

It is essential that you take note of the following rules, which apply to applications for special consideration in all first year Mathematics courses.

1. **Within 3 days** of the affected examination, or at least as soon as possible, you must submit a request for special consideration to UNSW Student Central ON-LINE. Please refer to link below for How to Apply for Special Consideration,

https://my.unsw.edu.au/student/atoz/SpecialConsideration.html#ApplyingforSpecialConsideration

2. **Please do not expect an immediate response from the School.** All applications will be considered together. See the information below.

3. You will **NOT be granted additional assessment in a course if your performance in the course** (judged by attendance, class tests, assignments and examinations) **does not meet a minimal standard.** A total mark of at least 40% on all assessment not affected by a request for special consideration will normally be regarded as the minimal standard for award of additional assessment as will at least 80% attendance at tutorial classes.

4. It is **YOUR RESPONSIBILITY** to find out FROM THE SCHOOL OF MATHEMATICS AND STATISTICS whether you have been granted additional assessment and when and where the additional assessment examinations will be held. **Do NOT wait to receive official results from the university,** as these results are not normally available until after the Mathematics additional assessment exams have started. Information about award of additional assessment is available from the School of Mathematics and Statistics in the following ways:

a) A **provisional** list of results in all Mathematics courses and of grants of additional assessment will be available via the “Maths&Stats marks” link in the UNSW Moodle module of your course. The date for this will be announced later.

b) On **Friday 19th July ONLY,** you may telephone the School Office (9385 7111) to find out whether you have been granted additional assessment and where and when it will be held. **Note that examination results will not be given over the phone.**

5. The **timetables** for the additional assessment examinations will be available on the Mathematics website at the same time as the provisional list of results.

The mid-year additional assessment examinations will be held on the days **Monday 22nd July to Tuesday 23rd July.**

6. If you have two additional assessment examinations scheduled for the same time, please consult the School of Mathematics and Statistics Office as soon as possible so that special arrangements can be made.

7. You will need to produce your UNSW Student Card to gain entry to additional assessment examinations.
IMPORTANT NOTES

- The additional assessment examination may be of a different form from the original examination and must be expected to be at least as difficult.

- If you believe that your application for special consideration has not been processed, you should immediately consult the Director of First Year Studies of the School of Mathematics and Statistics (Room 3073 Red Centre).

- If you believe that the above arrangements put you at a substantial disadvantage, you should, at the earliest possible time, send full documentation of the circumstances to the Director of First Year Studies, School of Mathematics and Statistics, University of New South Wales, Sydney, 2052.

In particular, if you suffer from a chronic or ongoing illness that has, or is likely to, put you at a serious disadvantage then you should contact the Student Equity and Disabilities Unit (SEADU) who provide confidential support and advice. Their web site is

http://www.studentequity.unsw.edu.au

SEADU may determine that your condition requires special arrangements for assessment tasks. Once the First Year Office has been notified of these we will make every effort to meet the arrangements specified by SEADU.

Additionally, if you have suffered a serious misadventure during semester then you should provide full documentation to the Director of First Year Studies as soon as possible. In these circumstances it may be possible to arrange discontinuation without failure or to make special examination arrangements.

Professor B. Henry
Head, School of Mathematics and Statistics
UNIVERSITY STATEMENT ON PLAGIARISM

Plagiarism is the presentation of the thoughts or work of another as one’s own.\(^1\) Examples include:

- direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement
- paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed\(^2\).

Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism. Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at:

[www.lc.unsw.edu.au/plagiarism](http://www.lc.unsw.edu.au/plagiarism)

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

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\(^1\)Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle.

\(^2\)Adapted with kind permission from the University of Melbourne
**Syllabus**

References are to the textbook by Epp, unless marked otherwise. F indicates the textbook by Franklin and Daoud and R indicates the book *Discrete Mathematics with Applications* by K.H. Rosen (6th edition). The UNSW Library has multiple copies of Rosen numbered P510/482A,B,C, etc.

The references shown in the righthand column are *not* intended to be a definition of what you will be expected to know. They are just intended as a guide to finding relevant material. Some parts of the course are not covered in the textbooks and some parts of the textbooks (even in sections mentioned in the references below) are not included in the course.


Within sections of the course, the topics may not be covered in exactly the order in which they are listed below.

<table>
<thead>
<tr>
<th>Topic</th>
<th>References A</th>
<th>References B</th>
</tr>
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<tbody>
<tr>
<td><strong>1. Sets, functions and sequences</strong></td>
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<tr>
<td>Sets, subsets, power sets. Equality, cardinality.</td>
<td>5.1, 5.3</td>
<td>1.2, 6.1, 6.3</td>
</tr>
<tr>
<td>Set operations: union, intersection, difference, cartesian product. Universal sets, complements.</td>
<td>5.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Russell’s paradox.</td>
<td>5.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Functions. Domain, codomain and range. Arrow diagrams. Ceiling and floor functions. Images and inverse images of sets.</td>
<td>7.1, 3.5</td>
<td>1.3, 7.1, 4.5</td>
</tr>
<tr>
<td>Injective (one-to-one), surjective (onto) and bijective functions.</td>
<td>7.3</td>
<td>7.2</td>
</tr>
<tr>
<td>Composition of functions</td>
<td>7.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Inverse functions.</td>
<td>7.2</td>
<td>7.2</td>
</tr>
<tr>
<td>Sequences, sums and products. Notation. Change of variable in a sum. Telescoping sums.</td>
<td>4.1</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>2. Integers, Modular Arithmetic and Relations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prime numbers and divisibility</td>
<td>3.1, 3.3</td>
<td>4.1, 4.3</td>
</tr>
<tr>
<td>Fundamental Theorem of Arithmetic</td>
<td>3.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Euclidean Algorithm</td>
<td>3.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Modular Arithmetic</td>
<td>3.4</td>
<td>4.4, 8.4</td>
</tr>
<tr>
<td>Solving Linear Congruences</td>
<td>R2.5</td>
<td>R3.7</td>
</tr>
<tr>
<td>General Relations</td>
<td>10.1</td>
<td>8.1</td>
</tr>
<tr>
<td>Reflexivity, symmetry and transitivity</td>
<td>10.2</td>
<td>8.2</td>
</tr>
<tr>
<td>Equivalence Relations</td>
<td>10.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Partially ordered sets and Hasse diagrams</td>
<td>10.5</td>
<td>8.5</td>
</tr>
</tbody>
</table>
## 3. Logic and Proofs

<table>
<thead>
<tr>
<th>Topic</th>
<th>References A</th>
<th>References B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof versus intuition. Direct proof.</td>
<td>F1</td>
<td>F1</td>
</tr>
<tr>
<td>Propositions, connectives, compound propositions.</td>
<td>1.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Truth tables. Tautology, contingency, logical equivalence.</td>
<td>1.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Implication, converse, inverse, biconditional.</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Rules of inference.</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Contrapositive, indirect proof, proof by contradiction.</td>
<td>1.2, 3.6, F6,3.7, 2.4,6,4.7, F6</td>
<td>3.1, 3.2, 3.3, F5</td>
</tr>
<tr>
<td>Quantifiers</td>
<td>2.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Proof of universal statements, exhaustion, proof by cases.</td>
<td>2.1, F2, F3</td>
<td>3.1, F2, F3</td>
</tr>
<tr>
<td>Proof of existential statements. Constructive and non-constructive proofs.</td>
<td>2.1, 3.1, F4, F6</td>
<td>3.1,4.1,F4,F6</td>
</tr>
<tr>
<td>Countereamples.</td>
<td></td>
<td></td>
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<tr>
<td>Negation of quantified statements.</td>
<td>2.1</td>
<td>3.2</td>
</tr>
<tr>
<td>Statements with multiple quantifiers.</td>
<td>2.2, 2.3, F5</td>
<td>5.2-5.4,F8</td>
</tr>
<tr>
<td>Common mistakes in reasoning. Converse and inverse fallacies. Begging the question, tacit assumption, etc.</td>
<td>2.3, 3.1</td>
<td>3.3,3.4.4.1</td>
</tr>
<tr>
<td>Mathematical induction</td>
<td>4.2-4.4, F8</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** In addition to the sections of Epp mentioned above, sections 4.2-4.5 and 4.7 (3.2-3.5,3.7 for edition 3) provide many useful worked examples of constructing proofs in elementary number theory.

## 4. Enumeration and Probability

<table>
<thead>
<tr>
<th>Topic</th>
<th>References A</th>
<th>References B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counting and Probability</td>
<td>6.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Multiplication Rule</td>
<td>6.2</td>
<td>9.2</td>
</tr>
<tr>
<td>Addition Rule</td>
<td>6.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Principle of Inclusion-Exclusion</td>
<td>6.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Pigeonhole Principle</td>
<td>7.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Permutations and Combinations</td>
<td>6.4, 6.5</td>
<td>9.5,9.6</td>
</tr>
<tr>
<td>Binomial and Multinomial Theorem</td>
<td>6.7, R4.6</td>
<td>9.7, R5.4</td>
</tr>
<tr>
<td>Discrete Probability</td>
<td>R4.4,6.1</td>
<td>R6.1,9.1</td>
</tr>
<tr>
<td>Recurrence Relations</td>
<td>8.2, 8.3</td>
<td>5.6,5.7,5.8</td>
</tr>
<tr>
<td>Recursively Defined Sets and Functions</td>
<td>8.1</td>
<td>5.9</td>
</tr>
</tbody>
</table>

## 5. Graphs

<table>
<thead>
<tr>
<th>Topic</th>
<th>References A</th>
<th>References B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic terminology. simple graphs, $K_n$. Directed graphs. Subgraphs, complementary graphs.</td>
<td>11.1</td>
<td>10.1</td>
</tr>
<tr>
<td>Degree, the Handshaking Theorem (Epp Theorem 10.1.1 (11.1.1 in ed. 3))</td>
<td>11.1</td>
<td>10.1</td>
</tr>
<tr>
<td>Bipartite graphs, $K_{m,n}$.</td>
<td>11.1</td>
<td>10.1</td>
</tr>
<tr>
<td>Adjacency and incidence matrices.</td>
<td>11.3</td>
<td>10.3</td>
</tr>
<tr>
<td>Isomorphism, isomorphism invariants.</td>
<td>11.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Walks, paths and circuits. Euler and Hamilton paths. Connected graphs, connected components.</td>
<td>11.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Trees, spanning trees.</td>
<td>11.5, 11.6</td>
<td>10.5,10.7</td>
</tr>
<tr>
<td>Weighted graphs. Minimal spanning trees. Kruskal and Dijkstra algorithms.</td>
<td>11.6</td>
<td>10.6,10.7</td>
</tr>
</tbody>
</table>