FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND STATISTICS

MATH2521

COMPLEX ANALYSIS

Semester 2, 2017

Cricos Provider Code: 00098G

MATH2521 – Course Outline

Information about the course

Course Authority: David Crocker

Lecturer: David Crocker RC-3094, email `d.crocker@unsw.edu.au`.

Consultation: The lecturer's consultation hours will be announced at lectures and on the MATH2521 Moodle web page in week 2. To arrange an appointment outside the "Definite" consultation hours, contact the lecturer by e-mail.

This will be for consultation on specific lecture material. For general consultation on theory, tutorial problems, past test and exam questions - you should see your tutor.

Credit, Prerequisites, Exclusions:

This course counts for 6 Units of Credit (6 UOC).

This is the 2nd running of this course which is an expanded version of the now defunct 3 UOC course MATH2520 Complex Analysis which has run for many years.

There is a higher equivalent of this course, MATH2621 Higher Complex Analysis, also a 6 UOC course, which replaces the previous 3 UOC course MATH2620 Higher Complex Analysis.

MATH1131/MATH1231 is assumed knowledge for this course.

Exclusions: MATH2069, MATH2621, MATH2520, MATH2620.

Lectures: There will be **three** lectures per week running in **Weeks 1 to 12**.

Lecture times and locations are:

Tuesday 10 – 11	**MATHEWS-D**
Tuesday 11 – 12	**MATHEWS-D**
Thursday 1 – 2	**MATHEWS-C**

Syllabus and Course Schedule

A Syllabus and Course schedule is located at the end of this handout.

Tutorials: There will be one tutorial per week running in **Weeks 2 to 13** (12 tutorials). Hence tutorials **start in Week 2**.

Possible tutorial times are **Wednesday 1 – 2**, **Thursday 11 – 12** and **Thursday 4 – 5**.

You may try and alter your tutorial times yourself via myUNSW up to the end of week 1.

No lectures or tutorials will be lost to Public Holidays this semester.

Attendance at tutorials will be recorded.

Moodle web page Further information, outline lecture notes, and other material will be provided via the Moodle web pages for MATH2521 via **UNSW Moodle** which can be accessed

on the web at the address

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

or by following the "UNSW Moodle" links on the School of Mathematics and Statistics web pages at

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

Course aims

This course aims to extend our understanding of differential and integral calculus from functions of a single real variable to functions of a complex variable. The differences between the two are often unexpected and very surprising. The theory of complex valued functions will give us many new insights into the real variable theory.

Relation to other mathematics courses

Mathematics may be divided into the broad categories of analysis (calculus), algebra, geometry and logic.

This subject fits into the analysis category and follows on from material you will have learned in first year algebra and calculus.

This course is part of the compulsory core aimed at those majoring in Mathematics.

Student Learning Outcomes

Students taking this course will gain an understanding of the basic theory of functions of a complex variable. They will:

- understand the main properties and examples of analytic functions;
- be able to compute and manipulate series expansions for analytic functions;
- know and be able to use the major integral theorems;
- be able to identify and classify zeroes and poles of functions and find their residues;
- understand the relationship between complex function theory and the theory of functions of a real variable.
- be able to calculate certain real improper and trigonometric integrals using complex analytic methods.

New ideas and concepts will be introduced in lectures and then applied to specific tasks in tutorials.

Through regularly attending lectures and applying themselves in tutorial exercises, students will reach the above outcomes.

Relation to graduate attributes

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: 1.**Research, inquiry and analytical thinking abilities**, 4. **Communication**, 6. **Information literacy**

Teaching strategies underpinning the course

New ideas and skills are introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in tutorials and assessments.

Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes, in the case of lectures, and, in the case of tutorials, by having made a serious attempt at doing for themselves the tutorial problems prior to the tutorials.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Assessment

Assessment in this course rewards students for working consistently at the tutorial problems throughout the session. It encourages the development of analytical thinking and the ability to understand and solve problems, and to express mathematics clearly in written form.

The **final mark** in MATH2521 will be a scaled aggregate mark based on

- **three 30–40 minute tests** (in **the Thursday 1 – 2 p.m. lecture in Weeks 5 , 8 and 12**) (10% each);
- the **final two hour examination** (70%) covering all of the course.

Assessment criteria: The main criteria for marking all assessment tasks will be clear and logical presentation of correct solutions.

Scaling of grades in MATH2521 will be performed in conjunction with the higher version of this course, MATH2621 Higher Complex Analysis, reflecting the greater difficulty of the higher course. Very few High Distinctions (if any) and only a small number of Distinctions will be given in MATH2521. Those seeking such grades should consider enrolling in the higher course. To enrol in the higher course, you need to have very good results from first year Mathematics or in other second year subjects.

Tests

Rationale: The Tests will give students feedback on their progress and mastery of the material.

Tests will be held in the **Thursday lecture** in weeks **5, 8** and **12**.

Sample Tests will appear on the UNSW Moodle web pages for MATH2521 about two weeks prior to the test.

You may bring your own non-programmable hand-held Scientific Calculator to the test. Calculators will not be provided for you.

Task	Date	Weighting	Duration	Material tested
Test 1	Week 5 – Thur Lect	10%	30 – 35 mins	Topics 1 – 3
Test 2	Week 8 – Thur Lect	10%	30 – 35 mins	Topics 4 – 8
Test 3	Week 12 – Thur Lect	10%	30 – 35 mins	Topics 9 – 13

Absences at Tests

There are no "make-up" tests, so if you miss a test and and you fail to provide documentation for a satisfactory reason why you missed the test, then you will receive an A for absent which gives a mark of zero for the test.

If you are absent from the test, then to avoid an A mark, you must provide a medical certificate for an illness or similar documentation, for example for a sudden bereavement. In that case an M will be recorded and your final mark will be calculated from the other assessment tasks as follows:

- With **one** M for a test, your assessment tasks will be re-weighted as:

$$\text{each remaining test } = \frac{100}{90} \times 10 \approx 11.11\%, \quad \text{exam } = \frac{100}{90} \times 70 \approx 77.77\%;$$

- With **two** M marks for the tests, your assessment tasks will be re-weighted as:

$$\text{the remaining test } = \frac{100}{80} \times 10 = 12.5\%, \quad \text{exam } = \frac{100}{80} \times 70 \approx 87.5\%;$$

- With **three** M marks for the tests, your assessment tasks will be re-weighted as:

$$\text{exam } = 100\%;$$

Examination

Duration: Two hours, consisting of 4 half-hour questions.

Rationale: The final examination will assess student mastery of the material covered in the lectures.

Weighting: The final examination will count for 70% of your final mark.

Further details about the final examination will be available in class closer to the time.

Past Exams and solutions

Near the end of session, a PDF of Past Exams and Solutions for the earlier course MATH2520 will be made available in the Course materials folder on Moodle.

It should be noted however, that this course MATH2521 has new material not covered in the older MATH2520 course - principally in Topics 6, 14 and 15 - but also some of the older topics in MATH2520 have been expanded upon in MATH2521. Hence the MATH2521 exam will contain contain questions on material not covered in the older MATH2520 course.

Additional resources and support

Tutorial Problems

A set of tutorial problems will be available as a PDF through the UNSW Moodle web pages for MATH2521 in the folder "Tutorial Problems" in the "Course Materials" folder.

These problems are for YOU to do to enhance mastery of the course.

SOME of the problems may be done in tutorials, but you will learn a lot more if you try to do them before the tutorial.

No solutions to the tutorial problems will be published. If you wish to see a solution to a tutorial problem you are having trouble with, raise that problem in your tutorial with your tutor.

The tutorial problem set does have short answers but not solutions.

Lecture notes

A set of skeleton lecture notes for the course will appear on the UNSW Moodle web pages for MATH2521 in the folder "Lecture Notes" in the "Course Materials" folder.

There will generally be one PDF per topic (15 topics in all) and you will be notified when the PDF for any topic is available for download.

These notes are not complete - in particular most examples listed in the notes are not solved in the notes - but will instead be done "live" at the lectures.

The notes therefore are NOT a substitute for attending lectures!

Textbooks

The text book for this course is:

J.W. Brown and R.V. Churchill *Complex Variables and Applications.* McGraw Hill, 9th edition, 2014, available from the UNSW bookshop.

You can use other editions.

A PDF showing a Conversion table for references to Topics to older editions of Brown & Churchill may be found on the Moodle page.

While it is **not** mandatory that students buy this book for this course, it is an excellent supplementary reference book for the course providing further explanations of the theory, worked examples and extra problems.

There are a few copies (mainly older editions in the library) and there may be a few on sale at the 2nd hand bookshop.

A brand new copy of the 8th edition from the UNSW bookshop is quite expensive, this year it costs approx $192. (!!)

Another useful extra **reference**, particularly for worked solutions to problems is:

M.R. Spiegel, *Complex Variables*, Schaum Outline Series, McGraw-Hill, 1964.

The content of the course will be defined by the lectures.

Moodle web page

All course materials will be available on the UNSW Moodle web pages for MATH2521 in the "Course Materials" folder. You should check regularly for new materials.

Maple

While there is no Maple component to be assessed in this course, every student in a mathematics course is given an account on the School of Mathematics and Statistics computer **Sigma** and

hence has access to a recent version of Maple. They can access this account through the School's computer labs in M020 and G012 in the School, Red Centre, Centre wing or remotely from another computer using NX Client for Windows, Linux or Mac or using X2go software.. Instructions on remote access will be placed in the Computing folder in the Course materials folder on Moodle.

Maple is ideally suited to computations with complex numbers and complex calculus. Many of Maple's in-built functions are defined for a complex variable. Integration can be adapted to contour integration. The `series` command can compute Taylor and Laurent series, the `residue` command can compute residues at singularities. You **may** wish to check some of your work using Maple.

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Administrative matters

Additional Assessment

The School policy on **Additional Assessment** is available on the School's web page at

```
Current Students > Student Services
 >  School Assessment Policies >  Additional Assessment Policies
```

Please read this document carefully!

Students have failed this and other 2nd & later year courses because they did not understand these rules!

In particular note the last section on **Concessional Additional Assessment**. Any student in a mathematics course who receives a **preliminary final mark- which includes the exam mark** of **45 − 49*** is automatically entitled to take the Additional Assessment exam and have a second chance at passing the course. The maximum final mark after Concessional Additional Assessment is 50.

(* The rules for Concessional Additional Assessment changed from S1 2016).

Please note the preliminary final mark includes the exam mark.

Even with 100% assessment in the three tests, this amounts to only 30% of the final mark, so **if you miss the final exam** and **if you do not put in a request for Special Consideration with a medical certificate for illness etc**, then you **do not** get Additional assessment and

you will fail the course!

Students who miss the final exam due to illness or misadventure must ask for special consideration and submit supporting documents such as a medical certificate through UNSW Student Central.

If this excuse is acceptable and pre-exam assessment is at least 40% and tutorial attendance at least 70% then normal additional assessment will be granted.

It is up to each student to find out **where** and **when** the Additional exams are held.

See the **Additional Assessment** web pages above for this information.

School Rules and Regulations

Fuller details of the general rules regarding attendance, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web page at

```
Current Students > Student Services
 >  School Assessment Policies
```

OR in the document **Important Information for Undergraduate students** mentioned above in relation to Additional Assessment.

Plagiarism and academic honesty

Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at

`http://student.unsw.edu.au/conduct`

and at the School of Mathematics and Statistics Web page at

```
Current Students > Undergraduate > Student Services
 > School Assessment Policies > Policy on Academic Misconduct
```

Syllabus and Course Schedule:

Here is a rough guide as to the schedule of material taught (see next page).

References are given to the "Text":

J.W. Brown and R.V. Churchill *Complex Variables and Applications.* McGraw Hill, **9th edition**, 2014

A PDF showing a Conversion table for references to Topics to older editions of Brown & Churchill may be found on the Moodle page.

Note in all editions of Brown & Churchill, the section numbering is independent of chapter, so for example a reference here 2.23 means section 23 which happens to fall in Chapter 2.

Unfortunately the section numbers are missing in the Table of Contents in the last two editions (8th and 9th) but are used in the text proper.

Topic	No. of Lects.	Lects	Weeks	Text
1. Introduction: Revision, basic topology functions and mappings	4	1-4	1,2	1 2.13 - 2.14
2. Limits, continuity, differentiability	2	5-6	2	2.15-2.23
3. Analytic and harmonic functions	2	7-8	3	2.25 - 2.28
4. Exponential, trigonometric and hyperbolic functions	1	9	3	3.30 3.37-3.39
5. Principal logarithms, and and complex exponents	2	10-11	4	3.31-3.36 3.40
6. Mobius transformations, mappings by elementary functions	2	12-13	4,5	8.96 - 8.107
7. Arcs, contour integrals and antiderivatives	2	14,16	5,6	4.41-4.49
Test 1, Topics 1-3	1	15	5	
8. Cauchy-Goursat theorem and the Cauchy integral formula	2	17-18	6	4.50-4.57 4.58
9. Taylor and Laurent Series	2	19-20	7	5
10. Evaluating integrals by CIF and Laurent Series	1	21	7	5
11. Singularities and residues	3	22-23, 25	8,9	6 (except 6.77, 6.84)
Test 2, Topics 4 - 8	1	24	8	
12. Real Improper integrals	3	26-28	9,10	7.85-7.88
13. Trigonometric integrals	1	29	10	7.92
14. Laplace transforms, applications, calculating inverse LTs by complex methods	2	30-31	10,11	7.95
15. Conformal mappings, transformation of harmonic functions application to temperature in a plate	3	32-34	11,12	9.112- 113 9.116-9.117 10.118- 10.121
16. Review	1	35	12	
Test 3, Topics 9 - 13	1	36	12	