KMA382: Applied Complex Variables and Transform Theory

First Semester 2013

Complex variable theory is one of the most beautiful and useful subjects in mathematics. This unit is about developing a deeper understanding of the functions that occur in applied mathematics, and complex variable theory is the tool to do this. This deeper understanding then allows us to develop powerful transform methods for solving differential equations (ODEs and PDEs) of practical importance. We will also look at integral equations, and methods for approximating certain integrals (that arise in diffraction theory, for example). This is a “methods” course, and ought to be useful to mathematicians, physicists and engineering scientists.

An approximate guide to the topics that will be discussed is as follows:

1. **Introduction to Complex Variables**
   The idea of an analytic function. The elementary functions. Contour integrals, Cauchy’s integral theorem and the integral formula. Taylor and Laurent series. The residue theorem. Evaluating real integrals using complex methods. Conformal mapping and applications.

2. **Special Functions**
   Second-order linear ODEs. Regular singular points, and the Fröbenius method. Legendre and Bessel functions.

3. **Separation of Variables**
   Solving PDEs using generalized Fourier series. Orthogonality.

4. **Fourier Transforms**
   The Fourier transform and its inverse. Evaluating Fourier transforms using complex variable theory. Convolution theorem. Solving PDEs using Fourier transforms. Fourier transform of generalized functions. A brief look at two-dimensional Fourier transforms and the Hankel transform.

5. **Laplace Transforms**
   The Laplace transform and its inversion formula (the Bromwich integral). The convolution theorem. Solving ODEs and PDEs using Laplace transforms.

6. **Integral Equations**
   Fredholm and Volterra integral equations. First and second kind equations. Fredholm integral equations with degenerate kernels. Integral equations with convolution kernels.

7. **Asymptotic Approximation Methods**
   Method of steepest descent. Method of stationary phase.

Lecture Times

At the moment, the lectures are planned for:

Monday	12:00 pm*	Physics room 333
Tuesday	3:00 pm*	Physics lecture theatre LT2
Wednesday	4:00 pm*	Physics lecture theatre LT3

*Room changes

Tutorial Time

At the moment, the University has scheduled the tutorial in:

Thursday 12:00 pm Maths room 254

I think we will probably only need a tutorial every second week, and there will be no tutorial in the first week.

Assessment

We'll finalize this in the first lecture, but I would recommend an assessment breakdown something like:

Exam at the end of semester (three 3 hours)	70%
Assignments during the semester (5 of them)	30%

Reference Books

E.B. Saff and A.D. Snider, *Fundamentals of Complex Analysis for Mathematics, Science and Engineering*, Prentice Hall, New Jersey (1976).

J.E. Marsden, *Basic complex analysis*, W.H. Freeman and Co., San Francisco (1973).

E. Kreyszig, *Advanced Engineering Mathematics*, 9th edition, Wiley, New York (2006).

G.E. Andrews, R. Askey and R. Roy, *Special functions*, Cambridge University Press, Cambridge (1999).

M. Abramowitz and I.A. Stegun (eds.), *Handbook of Mathematical Functions*, Dover, New York (1972).

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I will put material up on my homepage at
http://www.maths.utas.edu.au/People/Forbes/KMA382.html
I will also shove the stuff onto MyLo, if I can eventually make it work.