ICE-EM Access Grid Room Project

Subject Information Form

Note: Subject Information form due at AMSI preferably **27 January 2013**.
This form must be both electronically completed and transmitted.

Administration

1. Department and Institution

   School of Mathematics and Statistics
   The University of Sydney

2. Subject name and code

   Numerical Complex Analysis
   AMH7

3. Handbook entry URL, subject homepage URL, host honours student hand-out URL

   - Handbook entry URL
     `http://www.maths.usyd.edu.au/u/UG/HM/`
   - Subject homepage URL
     `http://www.maths.usyd.edu.au/u/UG/HM/`
   - Host Honours student hand-out URL
     `http://www.maths.usyd.edu.au/u/UG/HM/`

4. **Lecturer** name and contact details

Name:	Sheehan Olver
Phone:	(02) 9351 5782
Email:	sheehan.olver@sydney.edu.au
Homepage:	`http://www.maths.usyd.edu.au/u/olver/`

5. **Honours coordinator** name and contact details

Name:	Martin Wechselberger
Phone:	(02) 9351 3860
Email:	martin.wechselberger@sydney.edu.au

6. Start date, end date, number of teaching weeks

   Semester 1, 2013

Start date:	XXXX
End date:	XXXX
Number of teaching weeks:	12

7. Contact hours per week

   2 hours

8. Description of electronic access arrangements for students (for example, Black Board)

   XXXX

Academic

1. Overview of subject content

   This course examines the beautiful connection between complex analysis and numerical analysis. Rather than the algebraic convergence typically observed in many numerical algorithms; we can achieve exponential convergence by exploiting analyticity. This will allow us to rapidly solve problems to very high accuracy.

   Aims: By the end of the course, students will be able to construct and analyse numerical methods for: approximation of functions, calculation of integrals, finding all roots of a function, solving Laplace's equation in 2D, solving ODE boundary value problems and time evolution PDEs.

   Structure: The course will emphasize both hands-on numerical experiments and rigorous proofs of the convergence of the numerical methods. There will be two assignments, a final and a project.

2. Detailed syllabus, preferably week by week

   - Numerical Fourier series.

   Lecture 1: Review of Fourier analysis and approximation theory

   Lecture 2: Review of least squares

   Lecture 3: Convergence of Fourier series

   Lecture 4: Trapezium rule

   Lecture 5: The Discrete Fourier Transform (DFT)

   Lecture 6: The Fast Fourier Transform (FFT)

   - Numerical Laurent and Chebyshev series.

   Lecture 7: Review of complex analysis and Taylor serie

   Lecture 8: The DFT and Laurent series

   Lecture 9: Chebyshev series

   Lecture 10: Signal smoothing and root finding

   - Spectral methods.

   Lecture 11: Numerical differentiation and integration

   Lecture 12: Solving ODEs

   Lecture 13: Fast and sparse spectral methods

   Lecture 14: Practical functional analysis

   Lecture 15: Computing spectrum of operators

   Boundary value problems in the complex plane

   Lecture 16: Solving Laplace's equation

   Lecture 17: Riemann–Hilbert problems on the unit circle

   Lecture 18: The inverse scattering transform

   Lecture 19: Matrix-valued Riemann–HIlbert problems

   Quadrature.

   Lecture 20: Gauss and Clenshaw–Curtis quadrature

   Lecture 21: Oscillatory integrals and the method of steepest descent

   Lecture 22: Nonlinear steepest descent

   Lecture 23: Cauchy transforms

   Lecture 24: Summary

3. Detailed breakdown of assumed prerequisite knowledge, including host prerequisite subject URLs

   The course assumes a basic understanding of complex analysis, Fourier analysis, linear algebra, differential equations and computer programming in *Matlab* and/or *Mathematica*.

   MATH2962 Real and Complex Analysis is highly recommended.

4. Assessment

   - Exam/assignment/class work breakdown

Exam	40 %
Assignment	30 %
Project	30 %

   - Assignment due dates
     XXXX
   - Approximate exam date
     XXXX

5. Required student resources

   - Text/printed notes
     XXXX
   - Software (local access)
     XXXX

Institutional Honours Details

1. Weight of subject in total honours assessment at host department

   10%

2. Thesis/subject split at host department

   40% thesis
   60% course work (6x10%)

3. Honours grade ranges at host department

H1	=	80-100 %
H2a	=	75-79 %
H2b	=	70-74 %
H3	=	65-69 %