Advanced Techniques in Numerical Linear Algebra

MATH4202/7202

Dr Roger B. Sidje
Course Code: MATH4202/7202
Semester 1, 2005

Brief description of course content

The course is an introduction to some of the iterative algorithms used to solve sparse linear systems efficiently. Topics in the course include splitting methods (e.g. Gauss-Seidel), Conjugate Gradient, Multigrid methods, projection methods (GMRES, etc). In particular, the course will examine the underlying principles of conditioning, stability, and convergence of the methods.

Lecturer

Name: Dr Roger B. Sidje
Room number/ Building: 69-708
Phone number: 336-56142
Email: rbs@maths.uq.edu.au

Consultation hours: Monday, 4-5 pm. Feel free to approach the lecturer at other times during weekdays.

Tutorial Coordinator Dr Roger B. Sidje

Web page The course profile and course material can be found on the web at the following address: http://www.maths.uq.edu.au/courses/MATH4202

Class contact hours: 3L, 1T

Tuesday: 10 am, Room 67-341
Wednesday: 9 am, Room 67-341
Thursday: 9 am, Room 67-341

Wednesday: 1 pm, Room 7-326 (Tutorial)

Assumed background:

It is assumed that students are familiar with the basics of calculus, linear algebra, and programming. Students are responsible for filling any gaps in their assumed knowledge. Background reading may be needed to strengthen your understanding of certain aspects of the course material.
Course goals/rationale:

On completing this course students will:

- Have an understanding of classical iterative methods for sparse matrix problems.
- Have an understanding of their performance and convergence properties, and the importance of preconditioners.
- Have a general idea of application areas where sparse problems arise (e.g., PDEs).

Graduate Attributes:

The following graduate attributes will be developed in the course –

**In-Depth Knowledge of the Field of Study**

- A comprehensive and well-founded knowledge of the field of study.
- An understanding of how other disciplines relate to the field of study.
- An international perspective on the field of study.

**Effective Communication**

- The ability to collect, analyse, and organise information and ideas, and to convey those ideas clearly and fluently, in both written and spoken forms.
- The ability to interact effectively with others in order to work towards a common outcome.
- The ability to select and use the appropriate level, style and means of communication.
- The ability to engage effectively and appropriately with information and communication technologies.

**Independence and Creativity**

- The ability to work and learn independently.
- The ability to generate ideas and adapt innovatively to changing environments.
- The ability to identify problems, create solutions, innovate and improve current practices.

**Critical Judgement**

- The ability to define and analyse problems
- The ability to apply critical reasoning to issues through independent thought and informed judgement
- The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decisions.

**Ethical And Social Understanding**

- An understanding of social and civic responsibility
- An appreciation of the philosophical and social contexts of a discipline
- A knowledge and respect of ethics and ethical standards in relation to a major area of Study
- A knowledge of other cultures and times and an appreciation of cultural diversity.

Teaching and Learning Methods

There will be two lecture sessions and one tutorial session per week. Each session starts on the hour and concludes at 50 minutes past the hour.

- **Lectures:** Tues 10-10:50 am, Wed 9-9:50 am, both in 67-341.
- **Tutorials:** Wed 1-1:50 pm, in 7-326.
- **Public holidays:** Tuesday 26 April will be a MONDAY timetable.
- **Semester Break:** March 25 - April 3, 2005.
- **Examination:** No formal exam. The assessment will be based on a number of projects.

Students are expected to use tutorial sessions to discuss any of their questions concerning difficult parts of the lecture. Tutorials will also provide a good opportunity for discussing programming issues.

ASSESSMENT

- **Assessment scheme:** There will be one assignment with several parts. You will be expected to do your assignment in XHTML with MathML. The assignment will be evaluated with a MathML-capable browser (e.g., Netscape 7, Mozilla, Firefox).
- **Submission of assignments:** Assignments must be handed in class at the appropriate date.
- **If you miss an assignment:** In case of illness (or bereavement) you may be exempted from an assignment if a medical certificate (or other documentation) is received by the course co-ordinator within one week of the due date of the assignment. If you are exempted, then your assignment marks are weighted on a pro-rata basis. Note that ad hoc excuses (car trouble and the like!) will not be accepted; only documentation in connection with illness or bereavement. If you enrolled late then exemption will automatically be granted for anything missed before the date of enrolment.
- **Final Examination:** No final exam.
- **If you miss the final exam:** N/A.

Criteria for the award of grades

Your grade for this course will be determined by which of the following levels of achievement that you consistently display in the items of summative assessment.

Grade of 7: (86% - 100%) the student demonstrates an excellent understanding of the theory of the topics listed in the course outline and is highly proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 6: (75% - 85%) the student demonstrates a comprehensive understanding of the theory of the topics listed in the course outline and is proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 5: (65% - 74%) the student demonstrates a good understanding of the theory of the topics listed in the course outline and can apply the techniques to solve problems.
Grade of 4: (50 – 64%) the student demonstrates an understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 3: (45% - 49%) the student demonstrates some understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 2: (25 – 44%) the student demonstrates limited understanding of the theory of the topics listed in the course outline and demonstrates limited knowledge of the techniques used to solve problems. This includes attempts at expressing their deductions and explanations and attempts to answer a few questions accurately.

Grade of 1: (1 – 24%) the student demonstrates very limited understanding of the theory of the topics listed in the course outline and of the basic concepts in the course material. This includes attempts at answering some questions but demonstrating very limited understanding of the key concepts.

Assessment policy

Students should be familiar with the rules which relate to assessment in their degrees as well as general university policy such as found in the General Award Rules. These are all set out on the myAdvisor page on the UQ website


Plagiarism:

The University has adopted the following definition of plagiarism:

“Plagiarism is the action or practice of taking and using as one’s own the thoughts or writings of another, without acknowledgment. The following practices constitute acts of plagiarism and are a major infringement of the University's academic values:

- Where paragraphs, sentences, a single sentence or significant parts of a sentence are copied directly, and are not enclosed in quotation marks and appropriately footnoted;

- Where direct quotations are not used, but are paraphrased or summarised, and the source of the material is not acknowledged either by footnoting or other simple reference within the text of the paper; and

- Where an idea which appears elsewhere in printed, electronic or audio-visual material is used or developed without reference being made to the author or the source of that material.”

When a student knowingly plagiarises someone’s work, there is intent to gain an advantage and this may constitute misconduct.

Students are encouraged to study together and to discuss ideas, but this should not result in students handing in the same or similar assessment work. Do not allow another student to copy your work. While students may discuss approaches to tackling a tutorial problem, care must be taken to submit individual and different answers to the problem. Submitting the
same or largely similar answers to an assignment or tutorial problem may constitute misconduct.

For more information on the University policy on plagiarism, please refer to http://www.uq.edu.au/hupp/index.html?page=25128&pid=25075

**Supplementary examinations**

A supplementary examination may be awarded in one course to students who obtain a grade of 2 or 3 in the final semester of their program and require this course to finish their degree. You should check the rules for your degree program for information on the possible award of supplementary examinations. Applications for supplementary examinations must be made to the Director of Studies in the Faculty.

EPSA Faculty policy on the award of supplementary exams may be found via the Faculty Guidelines on Examinations from the EPSA student page http://www.epsa.uq.edu.au/index.html?page=7640&pid=7563

**Special examinations**

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies.

Applications for special examinations for central and end-of-semester exams must be made through the Student Centre. Applications for special examinations in school exams are made to the course coordinator.

More information on the University’s assessment policy may be found at http://www.uq.edu.au/hupp/index.html?page=25113&pid=25075

EPSA Faculty policy on the award of special exams may be found via the Faculty Guidelines on Examinations from the EPSA student page http://www.epsa.uq.edu.au/index.html?page=7640&pid=7563

**Feedback on assessment:**

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, model answers, lists of common mistakes and the like.

Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of six months following the release of results, examination scripts may be destroyed.

Information on the University’s policy on access to feedback on assessment may be found at http://www.uq.edu.au/hupp/index.html?page=25114&pid=25075

EPSA Faculty policy on assessment feedback and re-marking may be found at http://www.epsa.uq.edu.au/index.html?page=7674&pid=7564
Textbook and references

- **Text:** No set text.
- **References:** Templates, Golub and Van Loan's Matrix Computations.

Library contact:

The liaison librarian for the physical sciences disciplines is located in the Physical Sciences and Engineering Library in the Hawken Building and may be consulted for assistance in the course:

Leith Woodall  
Email: l.woodall@library.uq.edu.au  
Extension: 52367

Students with disabilities:

Any student with a disability who may require alternative academic arrangements in the course is encouraged to seek advice at the commencement of the semester from a Disability Adviser at Student Support Services.

Assistance for Students:

Students with English language difficulties should contact the course coordinator or tutors for the course.

Students with English language difficulties who require development of their English skills should contact the Institute for Continuing and TESOL Education on extension 56565.

The Learning Assistance Unit located in the Relaxation Block in Student Support Services. You may consult learning advisers in the unit to provide assistance with study skills, writing assignments and the like. Individual sessions are available. Student Support Services also offers workshops to assist students. For more information, phone 51704 or on the web http://www.sss.uq.edu.au/index.html.

Student Liaison Officer:

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.

The Student Liaison officer during 2005 will be Dr Peter Adams, Room 547 Priestley building, (email pa@maths.uq.edu.au)