Description: High Performance Numerical Computing

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cat-nbr</th>
<th>Class</th>
<th>Term</th>
<th>Mode</th>
<th>Units</th>
<th>Campus</th>
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<tr>
<td>CSC</td>
<td>2409</td>
<td>62009</td>
<td>1, 2007</td>
<td>ONC</td>
<td>1.00</td>
<td>Toowoomba</td>
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Academic group: FOSCI
Academic org: FOS003
Student contribution band: 2
ASCED code: 020199

STAFFING
Examiner: Leigh Brookshaw

REQUISITES
Pre-requisite: CSC1401 and MAT1102

RATIONALE
Many areas of computing in engineering, science, technology and games require programmers to have insight and skills in the implementation of common numerical computations. Programming high performance computers to rapidly perform large scale tasks requires considerable skill. Modern vector and super-scalar computers are very fast - but to achieve anything remotely like the peak speed requires special programming styles sympathetic to the computer architecture. Using fundamental algorithmic tasks of science, this course develops the ability to design good algorithms for modern computer architectures.

SYNOPSIS
This course develops skills in programming modern high performance computers. It examines some of the typical hardware architectures and how they affect performance and programming. Algorithms to illustrate the principles are chosen from a range of scientific tasks. The course includes the study of numerical solutions of linear and non-linear equations, numerical interpolation and curve fitting, the numerical solution of ordinary differential equations, and Monte Carlo simulation. Interaction utilising modern graphics is exploited.

OBJECTIVES
Completion of this course will enable students to:
1. describe the relevant architecture of modern high performance computers (Examination);
2. understand the principles of high performance programming using vector operations (Examination);
3. demonstrate an understanding of a variety of computer-based methods and their errors, used in the solution of numerical problems (Matlab Script Submissions 1-5);
4. choose appropriate techniques (including graphics) for particular applications and solutions (Matlab Script Submissions 1-5);
5. implement numerical solutions using computer-based techniques (Matlab Script Submissions 1-5).

**TOPICS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting (%)</th>
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<tbody>
<tr>
<td><strong>1. High performance computer architecture</strong></td>
<td>10.00</td>
</tr>
<tr>
<td>1.1. Computer Architecture, Different HPC Architectures, Performance Measures</td>
<td></td>
</tr>
<tr>
<td><strong>2. Vector programming</strong></td>
<td>20.00</td>
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<tr>
<td>2.1. Amdahl's Law; Matlab vector computer; Matlab programming; Vector Operations; Gantt charts; Loop interchange; Loop unrolling; Recursion</td>
<td></td>
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<tr>
<td><strong>3. Solving Linear and Nonlinear Equations</strong></td>
<td>20.00</td>
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<tr>
<td>3.1. Newton's method and other fixed point iteration; linear systems; condition numbers; Jacobi's iterative solution of linear systems; Newton's method for nonlinear systems</td>
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<tr>
<td><strong>4. Numerical Interpolation and Curve Fitting</strong></td>
<td>20.00</td>
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<tr>
<td>4.1. Interpolation with polynomials, cubic splines, derivatives and integrals of interpolants; Trapezoidal and Simpson's rule for numerical integration; least squares approximations</td>
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<tr>
<td><strong>5. Simulation and Monte Carlo methods</strong></td>
<td>15.00</td>
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<tr>
<td>5.1. Process simulation; Monte Carlo integration; Random Numbers</td>
<td></td>
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<tr>
<td><strong>6. Solution of ordinary differential equations</strong></td>
<td>15.00</td>
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<tr>
<td>6.1. Difference approximations; Euler's method; modified Euler's method; the Runge-Kutta RK4 method</td>
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</table>

**TEXT and MATERIALS required to be PURCHASED or ACCESSED**

ALL textbooks and materials are available for purchase from USQ BOOKSHOP (unless otherwise stated). Orders may be placed via secure internet, free fax 1800642453, phone 07 46312742 (within Australia), or mail. Overseas students should fax +61 7 46311743, or phone +61 7 46312742. For costs, further details, and internet ordering, use the 'Textbook Search' facility at [http://bookshop.usq.edu.au](http://bookshop.usq.edu.au) click 'Semester', then enter your 'Course Code' (no spaces).

Access to computer or internet facilities for computer programming.

All other materials required for this course can be accessed via the home page: [http://www.sci.usq.edu.au/csc2409](http://www.sci.usq.edu.au/csc2409).

The Student Edition of Matlab *Manual and CD*, Prentice-Hall,
REFERENCE MATERIALS

Reference materials are materials that, if accessed by students, may improve their knowledge and understanding of the material in the course and enrich their learning experience.

Department of Mathematics and Computing CDROM SET 1, S1, 2006 (available from the USQ Bookshop). This CD set contains course material, Windows and Linux Software relevant to this course offering only. For more information about the CD sets and their use, please refer to http://www.sci.usq.edu.au/cdrom.

Electronic resources for this course will be available via its home page:
http://www.sci.usq.edu.au/courses/csc2409

, , International Journal of High Performance Computing Applications,

(ISBN: 0471001163)


(ISBN: 0133976882)

(Addison-Wesley, Reading, Mass)

(ISBN 0 9712887 1 4)


(ISBN: 0534338925)

(ISBN: 047133328X)


(ISBN: 0070473285)


Reinders, James Vtune Performance Analyzer Essentials: measurement and tuning techniques for software developers, Intel Press, United States.
STUDENT WORKLOAD REQUIREMENTS

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>HOURS</th>
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<tbody>
<tr>
<td>Assessment</td>
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<tr>
<td>Examinations</td>
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<tr>
<td>Lectures</td>
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<tr>
<td>Private Study</td>
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<td>Workshops</td>
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ASSESSMENT DETAILS

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<tr>
<th>Description</th>
<th>Marks out of</th>
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<tr>
<td>MATLAB SCRIPT SUBMISSION 1</td>
<td>6.00</td>
<td>6.00</td>
<td>16 Mar 2007</td>
</tr>
<tr>
<td>MATLAB SCRIPT SUBMISSION 2</td>
<td>6.00</td>
<td>6.00</td>
<td>30 Mar 2007</td>
</tr>
<tr>
<td>MATLAB SCRIPT SUBMISSION 3</td>
<td>6.00</td>
<td>6.00</td>
<td>27 Apr 2007</td>
</tr>
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<td>MATLAB SCRIPT SUBMISSION 4</td>
<td>6.00</td>
<td>6.00</td>
<td>11 May 2007</td>
</tr>
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<td>MATLAB SCRIPT SUBMISSION 5</td>
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<td>6.00</td>
<td>25 May 2007</td>
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<td>2HR OPEN EXAMINATION</td>
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<td>70.00</td>
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NOTES

1. Examination dates will be available during the semester. Please refer to the examination timetable when published.

IMPORTANT ASSESSMENT INFORMATION

1 Attendance requirements:
   It is the students' responsibility to attend and participate appropriately in all activities (such as lectures, tutorials, laboratories and practical work) scheduled for them, and to study all material provided to them or required to be accessed by them to maximise their chance of meeting the objectives of the course and to be informed of course-related activities and administration.

2 Requirements for students to complete each assessment item satisfactorily:
   There are no attendance requirements for this course. However, it is the students' responsibility to study all material provided to them or required to be accessed by them to maximise their chance of meeting the objectives of the course and to be informed of course-related activities and administration.

3 Penalties for late submission of required work:
   If students submit assignments after the due date without prior approval then a penalty of 20% of the total marks available for the assignment will apply for each day late.

4 Requirements for student to be awarded a passing grade in the course:
   To be assured of receiving a passing grade, a student must achieve at least 30% in all of the weighted assessment items, achieve at least 50% of the total weighted marks available for the course. Students who do not qualify for a Passing grade may, at the discretion of
the Examiner, be awarded a Supplementary Examination and/or assigned additional work to demonstrate to the Examiner that they have achieved the required standard. It is expected that such students will have gained at least 45% of the total marks available for all summative assessment items.

5 Method used to combine assessment results to attain final grade:
The final grades for students will be assigned on the basis of the weighted aggregate of the marks obtained for each of the summative assessment items in the course.

6 Examination information:
In an Open Examination, candidates may have access to any material during the examination except the following: electronic communication devices, bulky materials, devices requiring mains power and equipment likely to disturb other students.

7 Examination period when Deferred/Supplementary examinations will be held:
Any Deferred or Supplementary examinations for this course will be held during the examination period at the end of the next offering of this course.

8 University Regulations:
Students should read USQ Regulations 5.1 Definitions, 5.6. Assessment, and 5.10 Academic Misconduct for further information and to avoid actions which might contravene University Regulations. These regulations can be found at the URL http://www.usq.edu.au/corporateservices/calendar/part5.htm or in the current USQ Handbook.

ASSESSMENT NOTES

9 Matlab scripts must be submitted electronically by the due date and time in the manner prescribed in the Introductory Book or as modified on the Course Website. Late submissions will not normally be accepted.