Application for New Course

1. Submitted by the College of Engineering  
   Department/Division offering the course: Computer Science  
   Date: August 1, 2000

2. Proposed designation and Bulletin description of this course:  
   (a) Prefix & Number: CS 623  
   (b) Full Title: Parallel Iterative Computing  
       Abbreviated Title (≤ 24 characters): Parallel Iterative Comp  
   (c) Lecture/Discussion hours per week: 3  
   (d) Laboratory hours per week: 0  
   (e) Studio hours per week: 0  
   (f) Credits: 3  
   (g) Course description:  
       The course will present advanced computational science techniques needed to support large scale engineering and scientific computations. Emphasis on iterative methods for solving large sparse linear systems and parallel implementations of iterative techniques.  
   (h) Prerequisites (if any): CS537 or consent of the instructor.  
   (i) May be repeated to a maximum of: Not applicable

4. To be cross listed as: Not applicable  
   Signature of cross-listing chair: ____________________________

5. Effective date: Fall 2001

6. Course to be offered: Fall  Spring  Summer  
   X

7. Will the course be offered annually; explain if not: offered once in a year or less frequently

8. Why is the course needed? This course is needed for students to learn modern high performance (parallel and distributed memory) computers and the application techniques that can be efficiently implemented on the parallel and distributed memory computers to solve important large-scale problems.

9. (a) By whom will the course be taught? Jun Zhang or Craig Douglas  
   (b) Are facilities for teaching this course now available? Yes  
       If not, what plans have been made for providing them?

10. What enrollment may reasonably be expected? 10  
    FEB 14 2001
11. Will this course serve students in the Department primarily? Yes
   Will it be of service to a significant number of students outside the Department? No
   If yes, under what area?

12. Check the category most applicable to this course:
   __ traditional; offered in corresponding departments elsewhere;
   X relatively new, now being widely established;
   ___ not yet found in many (or any) other universities

13. Is this course part of a new proposed program? No
   If yes, which?

14. Will adding this course change the degree requirements in any programs? No
   If yes, explain:

15. Attach a list of the major teaching objectives of the proposed course and outline
    and/or a reference list to be used: See attached

16. If the course is a 100-200 level course, please submit evidence (e.g., correspondence)
    that the Community College System has been consulted.
    Not applicable

17. Within the Department, who should be contacted for further information about the
    proposed course?
    Name: Jun Zhang or Craig Douglas       Phone: 257-3892/257-2326

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1Approval of this course will constitute approval of the program change unless other program modifications are proposed.
Signatures of Approval:

Department Chair: 

Dean of the College: 

Date of Notice to the Faculty: 1/26/01

Undergraduate Council\(^2\): 

University Studies\(^2\): 

Graduate Council\(^2\): 

Senate Council\(^2\): 

Date of Notice to the University Senate: 

Action other than approval: 

\(^2\)If applicable, as provided by the Rules of the University Senate
**Needed Skills**
Programming proficiency in Fortran or C.

**Learning Outcomes**
Students will learn how to use iterative methods for solving large sparse linear systems on high-performance computers. They will learn how to partition a domain, select algorithms, obtain and develop code for computing solutions in parallel environments. Students will gain hands-on experience in writing parallel programs on a shared-memory parallel computer using high-level directives.

**Week by Week Course Outline**
This is a sample outline. Exact outline will be determined by the instructor offering this course.

<table>
<thead>
<tr>
<th>Week</th>
<th>Activities</th>
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<tbody>
<tr>
<td>1st week</td>
<td>Parallel Computing Overview: high performance computers, parallel programming language and skills, parallel computing techniques;</td>
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<tr>
<td>2nd - 3rd weeks</td>
<td>Structured and Unstructured Matrices: discretized partial differential equations, graph representations, permutations and reorderings, sparse matrix storage schemes, basic sparse matrix operations;</td>
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<tr>
<td>4th week</td>
<td>Basic Iterative and Projection Methods: point and block relaxation methods, iteration matrices and preconditioning, general convergence results, general projection methods, parallel implementations;</td>
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<tr>
<td>5th week</td>
<td>Multigrid Methods: smooth and rough errors, restriction and interpolation, V cycle and W cycle algorithms, parallel multigrid methods;</td>
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<tr>
<td>6th - 7th weeks</td>
<td>Krylov Subspace Methods (I): Krylov subspace, Arnoldi's method, FOM, GMRES, conjugate gradient algorithm;</td>
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<td>8th - 10th weeks</td>
<td>Krylov Subspace Methods (II): Lanczos biorthogonalization, Lanczos algorithm for linear systems, BCG and QMR algorithms, transpose free variants, practical and parallel implementations;</td>
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<tr>
<td>11th week</td>
<td>Preconditioned Iterations: preconditioned conjugate gradient, preconditioned GMRES, flexible variants, preconditioned CG for normal equations;</td>
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<tr>
<td>12th - 13th weeks</td>
<td>Preconditioning Techniques: basic iterative methods as preconditioners, incomplete LU factorization, threshold strategies and ILUT, approximate inverse preconditioners, block preconditioners</td>
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<tr>
<td>14th - 15th</td>
<td>Parallel Preconditioners: block Jacobi preconditioner, polynomial preconditioners, multicoloring, multilevel ILU preconditioners, distributed ILU and SSOR.</td>
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</table>
Grading
Exact details about graded work in this course will be determined by the instructor offering the course and will be made available in the syllabus during the first class meeting. Typically, a student's grade will be determined by a weighted average of homework assignments, programming projects, midterm and final examinations. A typical weighting is:

- Homework: 25%
- Programming projects: 25%
- Midterm Examination: 25%
- Final Examination: 25%


Possible Textbooks
Textbooks will be determined by the instructor. Suggested textbooks:

- Iterative Methods for Sparse Linear Systems, Yousef Saad, 1996, PWS Publishing Company;