**NOTE:** Click once on shaded fields to type data. To check boxes, right click at box, click “Properties”, and click “Checked” under Default Values.

<table>
<thead>
<tr>
<th>DEPARTMENT/PROGRAM</th>
<th>Electrical and Computer Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE PREFIX/NUMBER</td>
<td>ECE 706</td>
</tr>
<tr>
<td>DATE OF LAST ACTION</td>
<td></td>
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<tr>
<td>COURSE TITLE</td>
<td>Advanced Parallel Computer Architecture</td>
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<tr>
<td>ABBREVIATED TITLE</td>
<td>ADV PARALLEL ARCH</td>
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<tr>
<td>SCHEDULING</td>
<td>Fall ☒ Spring ☐ Summer ☐ Every Year ☒</td>
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<tr>
<td>COURSE OFFERED</td>
<td>BY DISTANCE EDUCATION ONLY ☐ ON CAMPUS ONLY ☒ BOTH ON CAMPUS AND BY DISTANCE EDUCATION ☒</td>
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<tr>
<td>CREDIT HOURS</td>
<td>3</td>
</tr>
<tr>
<td>CONTACT HOURS</td>
<td>Lecture/Recitation 3 Seminar ☐ Laboratory ☐ Problem ☐ Studio ☐ Independent Study/Research ☐ Internship/Practicum/Field Work ☐</td>
</tr>
<tr>
<td>GRADING</td>
<td>ABCDF ☒ S/U ☐</td>
</tr>
<tr>
<td>INSTRUCTOR (NAME/RANK)</td>
<td>Gregory T. Byrd, Associate Professor</td>
</tr>
<tr>
<td>ANTIQUATED ENROLLMENT</td>
<td>Per semester 25 Max. per Section 25 Multiple sections Yes ☐ No ☒</td>
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<tr>
<td>PREREQUISITE(S)</td>
<td>ECE/CSC 506</td>
</tr>
<tr>
<td>PROPOSED EFFECTIVE DATE</td>
<td>Fall 2005</td>
</tr>
<tr>
<td>CATALOG DESCRIPTION</td>
<td>Advanced topics in parallel computer architecture. Hardware mechanisms for scalable cache coherence, synchronization, and speculation. Scalable systems and interconnection networks. Design or research project required.</td>
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</table>

**DOCUMENTATION AS REQUIRED**
- Please number all document pages
- Course Justification ☒
- Proposed Revision(s) with Justification ☐
- Student Learning Objectives ☒
- Enrollment for Last 5 Years ☐
- New Resources Statement ☒
- Consultation with other Departments ☒
- Syllabus (Old and New) ☒
- Explanation of differences in requirements of dual-level courses ☐

**RECOMMENDED BY:**

Department Head/Director of Graduate Programs  
Chair, College Graduate Studies Committee  
College Dean(s)  
Dean of the Graduate School

**ENDORSED BY:**

Date

**APPROVED:**

Date
Course Justification
Parallel computer architecture is an important sub-specialty of computer architecture, an active area of research for several ECE faculty. Research in parallel computer architecture is regularly published in IEEE journals and conferences. This course is designed to provide graduate students in-depth knowledge of the hardware mechanisms used to build scalable, high-performance multiprocessor systems, and the interaction of those mechanisms with modern processor and system architectures.

ECE 706 is intended as a follow-on to ECE/CSC 506, Architecture of Parallel Computers. That course covers the basic concepts of how parallel systems are designed and programmed. ECE 706 builds on that knowledge to explore advanced hardware mechanisms that improve performance and scalability.

Based on other advanced computer architecture courses, we anticipate an enrollment of approximately 20-25 students.

Student Learning Objectives
See syllabus.

New Resources
No new resources are required for offering this course.

Consultation with Other Departments
Because of potential overlap with existing parallel computing courses, faculty in Computer Science (CSC) were consulted. The proposed course was approved by the CSC Department Head and Director of Graduate Studies (meeting on Sept. 27, 2004).

----- Original Message -----  
From: David Thuente  
To: H. Joel Trussell  
Sent: Thursday, November 18, 2004 10:53 AM  
Subject: Re: endorsement for ECE 706 CAF  

Joel,

The appropriate CSC faculty have looked at the CAF for ECE 706, Advanced Parallel Computer Architecture, and they recommend endorsement of the course. I concur and look forward to continued cooperation with ECE.

David

David J. Thuente  
Director of Graduate Programs  
900 Main Campus Drive, Box 8207  
Department of Computer Science  
North Carolina State University  
Raleigh, NC 27695  
phone: 919-515-7003, fax 919-513-1895  
email: thuente@csc.ncsu.edu  
Room 195 Venture III
ECE 706: Advanced Parallel Computer Architecture  
NC State University  
Fall 2005  
Tues/Thurs, 11:20am - 12:35pm, Broughton 3218

Course Syllabus

<table>
<thead>
<tr>
<th>INSTRUCTOR</th>
<th>OFFICE HRS</th>
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| Dr. Greg Byrd (gbyrd@ncsu.edu)  
Assoc. Professor, ECE Dept.  
Partners I, Suite 2300  
(919) 513-2508 | MW 1:00-2:00, Partners I  
TH after class, as needed |

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<tr>
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<th>OFFICE HRS</th>
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<tbody>
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<td>TBD</td>
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</table>

Course Overview

This course addresses advanced topics in the design and implementation of large-scale parallel computers. The course material will primarily be recent and “classic” papers from the research literature, covering material that represents the current state of research in parallel architecture. A representative sample of topics for the course includes:

- hardware support for scalable cache coherence
- hardware mechanisms for synchronization
- speculation in scalable multiprocessors
- hardware/software tradeoffs and system design
- interconnection networks and network interfaces

The recommended text for the course is:

*Parallel Computer Architecture: A Hardware/Software Approach*  
David Culler and J. P. Singh with Anoop Gupta  

This is the same text used for ECE/CSC 506. I will not assign reading from the text, but I will try to point you to sections that help provide background for the readings.

Prerequisites

The prerequisite for this class is *ECE/CSC 506: Architecture of Parallel Computers*. If you have not had this class, or an equivalent class at another institution, see me immediately. I will not be reviewing ECE/CSC 506 material, and I will assume that you have a working knowledge of parallel programming and parallel architectures. Specifically, I will assume that you are very familiar with the following material in the text:

Chapters 1, 2, 5, 6, 8, 10, and Section 9.1.

Learning Objectives

Upon completion of this course, a student will be able to:
• describe mechanisms for enabling scalable coherence and consistency for shared memory multiprocessors;
• describe mechanisms for optimizing communication and synchronization in large-scale parallel systems;
• describe mechanisms for speculative execution in parallel systems;
• discuss cost/performance tradeoffs of interconnection networks and their impact on parallel system architectures;
• design and implement simulation code to model mechanisms for coherence, synchronization, and speculation;
• evaluate the performance of mechanisms for coherence, synchronization, and speculation, using full-system simulation tools.

Course Content
The following is a tentative list of topics and representative papers that may be covered in class. This list is subject to change.

• Scalable cache coherence (7 lectures)

• Synchronization (5 lectures)

• Midterm Exam (1 lecture)

• Prediction and speculation (5 lectures)

• Interconnection networks (4 lectures)
  • C. B. Stunkel, “Commercially Viable MPP Networks.” International Conference on Parallel Processing Workshop on Challenges for Parallel Processing, 1996.
  • Myrinet, Infiniband, etc.

• System design and hardware/software tradeoffs (6 lectures)

Assignments and Grading
The overall grade will be a weighted average of the following components:

• Midterm Exam (20%)
• Final Exam (20%)
• Three projects (60%)

Exams (40%)
The final exam will emphasize material since the midterm exam.

Projects (60%)
There are three project assignments. The first two are assigned projects, to be completed individually. The third is a student-selected project, which may be completed either individually or in pairs.

The first two projects are based on the Simics system simulator. The first project (10%) will involve using the simulator to measure and report benchmark performance. The second project (15%) will involve writing simulation code to model a specific multiprocessor architecture. Grades for these two projects will be based on a written report.

I recommend the use of Simics for the third project (35%), but other tools can be used if you get permission first. This project should investigate the implementation and performance of a specific architectural feature. Students may work in pairs, but I must be convinced that a two-person project is significantly more ambitious than a one-person project. The third project grade will be based on a presentation and final project report. The presentations will be given during the last couple of class
periods. The final written report is due by midnight on the last Friday before final exams (December 3). There will be no extensions granted for the final report. (I need time to grade them, and I do not want to interfere with studying for exams.)

Course Grade
The total course grade is a weighted average, with the weights described above. I guarantee the following assignment of grades based on the weighted average:

- 97-100: A+
- 92-96: A
- 90-91: A-
- 87-89: B+
- 82-86: B
- 80-81: B-
- 77-79: C+
- 70-76: C
- 67-69: C-
- 57-66: D
- 56 or below: F

I reserve the right to shift the numerical cutoff points down (but never up), based on overall class performance, problems with a particular assignment, etc. This adjustment rarely happens in a graduate-level course.

Resources and Policies

Computer Resources

Course home page: http://courses.ncsu.edu/ece706/lec/001/
Message Board: (see home page)
Course locker: /afs/eos/lockers/workspace/ece/706/001

All class announcements will be posted to the message board. The web site will also contain project assignments and other relevant information. The message board is intended for questions and comments about projects, lectures, or anything else. Anyone in the class may post to the message board. If inappropriate material is posted, the message board will be deleted.

I may choose to broadcast an email message to the entire class for time-critical announcements. For the most part, however, you are responsible for getting information in class, from the web site, or from the message board.

A course locker will be provided for projects. This space may be used only for class-related activities. Anything stored in the locker will be deleted at the end of the semester and cannot be recovered.

Late Assignments
Assignments are due at the beginning of class on the specified date. Late assignments will be not be accepted, except for university-excused absences. If you have a certified medical excuse or instructor approval, you may receive full credit if the assignment is turned in as soon as possible.

http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php

Office Hours
Scheduled office hours are held in my office (Centennial Campus) and are reserved for students in this class. I will also be available after class for questions, as needed. You can drop by my office anytime, but if you want to make sure I’m available, call or email me to arrange an appointment.
Academic Integrity

All exams, paper reviews, and presentations are individual assignments, unless otherwise stated in writing. Evidence of cheating, plagiarism, or other violations of the Code of Student Conduct will be investigated and, if appropriate, referred to the Office of Student Conduct for disciplinary review.

Recycling of projects from another class will be considered an academic integrity violation. If you wish to extend or refine the work done for another class project, this must be approved in advance, and you must provide the results from the previous project.

Code of Student Conduct:  

Office of Student Conduct:  
http://www2.ncsu.edu/student_affairs/osc/

Inclement Weather

The class will follow the University’s closure policy. If classes are not cancelled, I will make every effort to be in class on time, and so should you. Please do not send me email asking whether class is going to meet. Instead, check the University website or the weather hotline (513-8888).

Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653.  
http://www.ncsu.edu/provost/offices/affirm_action/dss/

For more information on NC State's policy on working with students with disabilities, please see:  
http://www.ncsu.edu/provost/hat/current/appendix/appen_k.html

Important Dates

Aug 17: First day of classes  
Sep 6: Project #1 due  
Oct 6: No class – fall break  
Oct 11: Project #2 due  
Oct 13: Midterm Exam  
Oct 21: Last day to drop class or change from credit to audit.  
Oct 27: Project #3 proposal due  
Nov 24: No class – Thanksgiving  
Dec 3: Last day of classes, Project #3 report due  
Dec 7: Final Exam, 8-11am