Parallel Architectures and Systems

CS/CE 6399: "Parallel Architectures and Systems"

A comprehensive study of the fundamentals of parallel systems and architecture. Topics including basic parallel algorithms, parallel programming environment, fine-grain parallelism such as VLIW (used in DSP processors) and superscalar, parallel computing paradigm of shared-memory, distributed-memory, interconnection networks, optical computing, systolic arrays, cache coherence, compiling techniques to improve parallelism, scheduling theory, loop transformations, loop parallelizations, real-time systems, and run-time systems.

Text:

(Not required) David Culler and Jaswinder Pal Singh, *Parallel Computer Architecture,* Morgan Kaufmann, 1999, ISBN 1-55860-343-3.

Class Handouts.

Professor in Charge: Edwin Sha

Course Goals:

To provide a integrated survey of available technologies for parallel computing, and study the fundamental issues on hardware, software and applications for parallel processing.

Prerequisites/Corequisite: Basic knowledge in operating systems such as processes and threads.

Important Dates:

- Student Term Project Presentations: April 22 and April 27, 2010.
- Term Project Due: April 29 by 11am to my Ofice ES 3.226.
- Spring break: March 15 to March 19.

Course Policy:

- Class participation is important. For your own sake, you should not miss any of the classes. There will be several pop-up quizzes in class. If you miss any, you get 0 point for that pop-up quiz.
- If you cheat in any exam or homework, you will be reported to the school and fairly punished. Do not even try. I have seen cases where students were evicted from school. The bad record would be permanently stored.
- I have been spending a lot of time preparing the course and would like to give you the best that a good student at UTD deserves to have. I am very serious in good teaching. If you are not serious in learning, please do not take this course.
- A penalty of 10% deduction each day for late submission of homework will be given and after 5 days, 0 point will be given.

- After the final grade is given, a student should not come to "negotiate" a better grade. I am very fair. In my whole teaching career, I have never changed a student grade after it is given.

Topics:

Overview of Computer Architectures
Introduction
    Paradigms of Parallelism
    Measures of Performance
Parallel Architectures
    Survey of Interconnection Networks
    Examples of Parallel Systems
    Examples of Applications on Various Systems
Shared-Memory Parallel Systems
    Issues on Memory
    Cache Coherence
Distributed-Memory Parallel Systems
    PVM and MPI
    Programming Examples
Data-Parallel and Data-Flow Systems
    Connection Machine CM5
    Data-Flow Models
Parallel Programming Concept
Interconnection Networks
    Routing
    Fault-Tolerance
Instruction-Level Parallelism
    TI DSP Processors VLIW architecture
    Intel IA-64 Architecture
Parallel Algorithms
    Sorting and Fast Fourier Transformation
    Basic Parallel Algorithms Techniques
    Graph Algorithms
Application-Specific Parallel Systems
    Data-Path Design
    Parallel and Pipelined Design
Scheduling Parallel Programs
    Optimal Scheduling Algorithms
    Scheduling Heuristics
Loop Transformation and Scheduling
Parallelizing Serial Programs
    Data Dependency Test
    Parallelization Techniques
Real-Time Systems
Student Presentations of Various Topics

Computer Usage: Homeworks and term project may involve computer programming at network of

workstations by using PVM, MPI, etc.
References:

R. Allen and K. Kennedy, *Optimizing Compilers for Modern Architectures*, Morgan Kaufmann, 2002.

M. Quinn, *Parallel Programming in C with MPI and OpenMP*, McGraw Hill, 2004.

Grama, Gupta, Karypis and Kumar, *Introduction to Parallel Computing*, Secod Edition, Addison Wesley, 2003.

T. G. Lewis and H. El-Rewini, *Introduction to Parallel Computing*,
Prentice-Hall, Englewood Cliffs, NJ, 1992.

K. Mani and S. Tayler, *An Introduction to Parallel Programming* Jones and Barlett Publishers, 1992.

Ian Foster, *Designing and Building Parallel Programs*, Addison-Wesley, 1994.

Michael Wolfe, *High Performance Compilers for Parallel Computing*,
Addison-Wesley, 1996, ISBN 0-8053-2730-4.

U. Banerjee, *Loop Parallelization*, Kluwer, 1994.

J. JaJa, *An Introduction to Parallel Algorithms,* Addison-Wesley, 1992.

F. T. Leighton, *Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes*, Morgan Kaufmann Publishers, 1992.

Grading: **Subjet to change. Not final yet.**

Homework, projects, in-clsss quizes:	75%
Term Project:	20%
Participation and presentation:	5%