PREF CSE4351/5351, *Parallel Processing,* Spring 2020

Instructor(s): Ishfaq Ahmad

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Class Hours: Tuesday: 7:00 to 9:50PM.

Office Hours: 5:00 to 6:30pm

Time and Place of Class Meetings: NH 108

Description of Course Content: In this course you will learn the fundamentals of high-performance parallel computing including, various kinds of system architectures, design methodologies, various programming models, performance evaluation, parallelizing techniques, parallel algorithms and resource management of parallel and distributed systems. In addition, advanced topics such as multi-core (CPU/GPU) processors, and energy-aware computing will be reviewed. The course starts as an introductory course but includes advanced feature as well as a great deal of research element. At the end of the course, you should be able to understand the difference between various parallel computing approaches, and utilize parallel and distributed computing for solving real-world problems.

Student Learning Outcomes: Students learn parallel processing including various kinds of system architectures, design methodologies, various programming models, performance evaluation, parallelizing techniques, parallel algorithms and resource management of parallel and distributed systems, and applying it to solve advanced scientific and engineering problems.

Required Textbooks and Other Course Materials: Class notes, books chapters, MPI manual.

Descriptions of major assignments and examinations: 3-4 Programming assignments, presentations and final report.

Attendance: Attendance may be taken.

Grading:

3-4 Homeworks (30%)

Presentations (30%)

Final Report (40%)

Reference Books:

1. Scalable *Parallel Computing* by Hwang and Xu
2. *Parallel Computing* by M. Quinn
3. *Introduction to Parallel Computing* by Grama and Kumar
4. MPI manual

Expectations for Out-of-Class Study: This is a three credit course and requires learning programming. Students must spend time to study the material and not just rely on class lecture notes. The textbook is the main teaching material.

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/aao/fao/).

Disability Accommodations: UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including *The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA),* and *Section 504 of the Rehabilitation Act.* All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of a letter certified by the **Office for Students with Disabilities (OSD).** Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting:
The Office for Students with Disabilities, (OSD) www.uta.edu/disability or calling 817-272-3364.
Counseling and Psychological Services, (CAPS) www.uta.edu/caps/ or calling 817-272-3671.
Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Title IX: *The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit uta.edu/eos. For information regarding Title IX, visit* www.uta.edu/titleIX.

Academic Integrity: Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

> *I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*

I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Lab Safety Training: The course will include an *optional& lab. Students registered for this course must complete all required lab safety training prior to entering the lab and undertaking any activities. Once completed, Lab Safety Training is valid for the remainder of the same academic year (i.e., through the following August) and must be completed anew in subsequent years. There are no exceptions to this University policy. Failure to complete the required training will preclude participation in any lab activities, including those for which a grade is assigned.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

Student Feedback Survey: At the end of each term, students enrolled in classes categorized as "lecture," "seminar," or "laboratory" shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit http://www.uta.edu/sfs.

Final Review Week: A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is located [insert a description of the nearest exit/emergency exit]. When exiting the building during

an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Student Support Services: UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at http://www.uta.edu/universitycollege/resources/index.php

Course Schedule

Introduction

- Basics of high-performance computing
- Driving forces and technology constraints
- Types of parallelism
- Classes of parallel computers, SIMD and MIMD architectures
- Multicores and GPUs
- Scalability Issues
- Interconnection networks
- Routing and communication techniques
- Clustering
- Cloud Computing

Basic Parallel Programming

- Inter-process communications
- Programming models
- SIMD, MIMD and SPMD programming
- Parallelism issues
- Synchronization
- Computing styles of commercial machines

Performance Analysis Methods

- Various performance measures
- Performance analysis methods
- Amdahl's Law Gustafson-Barsis Law
- Speedup and scalability
- Benchmarking

Parallel Paradigms and Programming Models

- Distributed-memory message passing programming (MPI)
- Shared memory programming (Threads)
- SIMD and GPU programming

Comparison of programming models

Parallel Algorithms

Parallelizing algorithms
Linear equation solvers
Matrix algorithms
Sorting algorithms
PDEs and FFTs

Resource Management

Partitioning techniques
Mapping algorithms
Static and dynamic load balancing
Scheduling

As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. –Dr. Ishfaq Ahmad."

Emergency Phone Numbers: In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911. Non-emergency number 817-272-3381