Boston University
College of Liberal Arts

Computer Science Department
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CLA CS-551

Parallel Computing
Models, Languages, and Architectures

Lectures Meeting Place: B29 **Time:** Tue & Thu (9:30am – 11:00pm)

Lab Meeting Place: TBA **Time:** Tue (6:00pm – 7:30pm)

Instructor: Azer Bestavros
- ◇ **Office:** MCS-276
- ◇ **Office Hours:** Thu 11:00 – 12:30pm, or by Email-arranged appointments
- ◇ **Email:** best@cs.bu.edu
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Teaching Fellow: Bob Carter
- ◇ **Office:** ERB-107 (lab)
- ◇ **Office Hours:** Tue 1:30pm - 3:00pm and Thu 11:00am - 12:30pm
- ◇ **Email:** carter@cs.bu.edu
- ◇ **Phone:** 353-4758

Objective:
This course examines a palette of parallel programming models and languages that are suitable for different architectures and applications. Architecture independent programming methodologies will be contrasted to those targeted at Data-flow, Data-parallel, Pipelined, Shared Memory, or Message Passing architectures. Lab assignment provide hands-on experience with a host of parallel programming languages.

Prerequisites:
CS-420: Introduction to parallel computing is required, unless waived by instructor.
CS-320/CS-520: An exposure to Programming Languages is recommended.
CS-450/CS-550: An exposure to Computer Architecture is recommended.

Topics:
The material covered will encompass topics in parallel computer architectures, parallel programming models, and languages. Appropriate examples for existing or proposed systems will be surveyed and compared.

Textbook and References:

- ◇ **Textbook:** *Advanced Computer Architecture: Parallelism, Scalability, Programmability* Kai Hwang, McGraw-Hill Series in Computing Science, 1993.
- ◇ *Introduction to Parallel Algorithms and Architectures: Arrays/Trees/Hypercubes* F.T. Leighton, Morgan Kaufmann Publishers Inc., 1992.
- ◇ *Computer Architecture: A quantitative approach* John Hennesy and David Patterson, Morgan Kaufmann Publishers Inc., Second Printing 1990.
- ◇ *High-Performance Computer Architecture* Stone, Addison Wesley., Third Edition.
- ◇ *Computer System Architecture* Mano, Prentice Hall, Third Edition.
- ◇ *A collection of papers from various journals and conference proceedings – to be distributed.*

Class participation:

- ◇ Class participation is vital for a full understanding and appreciation of the material to be covered. This must be complemented with a consistent and thorough reading of the assigned portions of the textbook for a given lecture.

Homeworks and Tests:

- ◇ There will be a number of homeworks (≈ 4) spread out throughout the course. In addition, there will be a number of small projects on the CM-5 and on simulated architectures.
- ◇ In addition to the homeworks there will be a final exam.

Co-requisite Lab-seminar:

The co-requisite lab-seminar is a forum where students from a number of computational science courses at Boston University present their work. This lab-seminar will provide CS-551 students with an exposure to a variety of problems and algorithms, which can be tailored for implementation on various architectures, using the appropriate model and language. Conversely, the contribution of this class to the co-requisite lab-seminar will be in the form of comparative studies of the suitability of various programming models for the clean expression and efficient implementation of algorithms on particular architectures.

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Fall 1995
Syllabus

Class	Topic	Readings
9/13	First class meeting: Motivation and Overview	Ch.1
9/15	PRAM and VLSI complexity models	Ch.1
9/20	Software Parallelism: Data and Control Flow	Ch.2
9/22	Hardware Parallelism: Network Architectures	Ch.2
9/27	Scalability: Applications and Metrics	Ch.3
9/29	Scalability: Speedup laws and Analysis	Ch.3
10/04	Processors and Memories: Basic and Superscalar Processors	Ch.4
10/06	Processors and Memories: Memory Management and Hierarchy	Ch.4
10/11	Multiprocessing: Communication and Memory Design Issues	Ch.7
10/13	Multicomputing: Overview and Design Issues	Ch.7
10/18	Multivector Processing: Techniques and Examples (Cray & Futjitsu)	Ch.8
10/20	SIMD Processing: Techniques and Examples (CM-2 and MasPar)	Ch.8
10/25	MIMD Processing: Techniques and Examples (CM-5)	Ch.8
10/27	Shared Memory Processing and Multithreading	Ch.9
11/01	Fine-Grain Multicomputers: MIT J-Machine and Caltech Mosaic C	Ch.9
11/03	Multithreaded Scalable Machines: Dash, KSR-1, and Tera	Ch.9
11/08	Dataflow and Hybrid Machines	Ch.9
11/10	Parallel Programming Models: An overview	Ch.10
11/15	Architecture Independent Models: Unity	Handout
11/17	Parallelizing Compilers: Dependence Analysis and Scheduling	Ch.10
11/22	Parallelizing Compilers: Loop Transformations and Pipelining	Ch.10
11/24	Fall Recess (Thanksgiving)	
11/29	Programming: Shared Memory and Message Passing Paradigms	Ch.11
12/01	Programming: Decomposition Techniques	Ch.11
12/06	Operating Systems and Environments: An Overview	Ch.12
12/08	(Slack)	
12/13	(Slack)	
12/19	Final exam	

* *Changes to this schedule will be announced if need be.*