DEGREE CURRICULUM

HIGH-PERFORMANCE COMPUTING

Coordination: Francesc Giné

Academic year 2013-14

2013-14

Subject's general information

Subject name	High-performance Computing
Code	103059
Semester	2n Quadrimestre Màster Enginyeria Informàtica
Typology	Obligatòria
ECTS credits	6
Theoretical credits	0
Practical credits	0
Coordination	Francesc Giné
Department	Informàtica i Enginyeria Industrial
Important information on data processing	Consult this link for more information.
Language	Català 50% Anglès 50%
Office and hour of attention	Dijous de 15h30' a 17h al despatx 3.09 de l'EPS

FRANCESC GINE DE SOLA

Subject's extra information

To follow this course, the student should have solid knowledge of structured programming, and Architecture and Computer Technology. Specifically, it is important that the student has achieved in deep the concepts of memory hierarchy and pipelining.

Learning objectives

See competences

Competences

University of Lleida strategic competences

- Correctness in oral and written language.

Degree-specific competences

- Capacity to apply mathematic, statistical and AI methods to model, design and develop smart and knowledge-based applications, services and systems.
- Capacity to comprehend and apply high performance knowledge and numeric or computational methods to engineering problems

Degree-transversal competences

- Capacity to transmit information, ideas, problems and solutions to both specialized and non-specialized audience
- Capacity to draft, design and implement projects and/or give novel solutions, using engineering-related tools

Subject contents

1. Introduction: High Performance Computing
2. Performance analysis and benchmarking:
    - Metrics
    - Performance,
    - Bechmarks
    - Amdhal Law.
3. Introduction to the parallel processing:
    - Introduction
    - Concepts
    - Limits of the parallel processing
4. Parallel algorithms
    - Parallel programming models
    - Design of parallel applications
5. Shared-memory Parallel Programming with OpenMP
    - Main Characteristics
    - Parallel Regions
    - Data Scoping
    - OpenMP worksharing for loops
    - Reductions
    - Loop Scheduling

    - Synchronization
6. Distributed-memory Parallel Programming with MPI
    - Main Characteristics
    - Messages and Point-to-point communications
    - Collective communication
    - Grouping Data for communication
    - Communicators and Topologies
7. Cloud Computing
    - Cloud Essentials
    - Anatomy of the cloud
    - Oportunities
    - Amazon cloud
8. Parallel computers
    - Types of parallel computers
    - Vectorial processors
    - Array processors

Methodology

Every week, each student will receive:

- Three hours of class attendance. These classes will be conducted both in the classroom, explaining the theoretical content of the course, accompanied by illustrative examples and problem solving, as the lab, explaining the contents in a more practical way. As a support material of the class, we will follow the slides for the course.
- Support materials to follow the subject in a non-attendance way.

The evaluation is continuous throughout the semester and consists of five different parts:

- A written test.
- Three practices: benchmarking, openMP and MPI.
- A report about a supercomputing infraestructure.

Development plan

- **Week 1**: Introduction: High Performance Computing
- **Weeks 2-3**: Performance analysis and benchmarking
- **Weeks 4-5**: Introduction to the parallel processing
- **Week 6**: Parallel algorithms
- **Weeks 6-8**: Shared-memory Parallel Programming with OpenMP
- **Week 9**: Partial Exam
- **Weeks 10-12**: Distributed-memory Parallel Programming with MPI
- **Weeks 13-14**: Cloud Computing
- **Week 15**: Parallel Computers

Evaluation

There is a continous evaluation and consists of the following five tests compared with the corresponding percentage of the final mark of the course:

- First practice benchmarking: 10%
- First partial exam: 25%
- Second practice OpenMP: 20%
- Third practice MPI: 25%
- Work supercomputer - Cloud Computing: 15%
- Oral Presentation: 5%

Therefore, the final mark for the course will be:

Final grade = 10%Benchmarking+20%OpenMP+25%MPI+25%Partial Exam+15% Supercomputer Work+5% Oral Presentation
The practices of the previous year can be recognized retaining the same result obtained in the previous year.

Students who fail the continuous assessment with a score lower than 5 shall be entitled to recover the partial exam that will count 25% of the final mark.

Bibliography

I. Foster

Designing and Building Parallel Programs

Addison-Wesley, 1994

P.S. Pacheco,

Parallel Programming with MPI,

Morgan Kaufmann Publishers , 1997

-R. Chandra, L. Dagum, D. Kohr,

Parallel Programming in OpenMP,

Morgan Kaufmann Publishers , 2001