University POLITEHNICA of Bucharest
Faculty Electronics, Telecommunications and Information Technology
Department/Chair: Applied Electronics and Information Technology
Academic year: 2010-2011

SUBJECT IDENTIFICATION

1. SUBJECT TITLE

Subject title:	**Parallel Computing**
Code:	04.T.08.O.508
Tenured Professors:	Prof. Felicia Ionescu
Type:	technical domain
Number of course hours:	28 hrs
Number of application hours:	28 hrs
Number of credit points:	4
Semester:	8
Package:	specialized curricular area
Prerequisites:	attending the following subjects: - Computer programming - Data structures and algorithms - Object-Oriented programming - Computing systems architecture - Operating systems

2. OBJECTIVES OF SUBJECT

- *For courses*: We study the use of multiple processors cooperating to solve a common task, as well as related issues in computer architecture, performance analysis, prediction and measurement, programming languages and algorithms. We focus on general principles of parallel computing and state-of-the-art parallel algorithms for large-scale computation.

- *For applications*: Programming at least one parallel computer is required. Possibilities include multiprocessors and message-passing systems.

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3. SPECIFIC COMPETENCIES

The main purpose of this subject is to develop the student abilities to evaluate the possibilities of parallel approach for different applications, and to develop parallel algorithms for solving intensive computational problems for different computing platforms (general-purpose or specialized).
According to the specific skills standardized by ACPART grids for Information Engineering specialization, studying this course will offer students the skills:

C3.1 Identification of classes and methods for solving problems specific to information systems
C3.4 benchmarking, including the experimental resolution alternatives to optimize the performance of software applications
C4.5 The development, implementation and integration software solutions

4. SYLLABUS

a. *Course*:

Chapter	Contents	Nr. Hours
1.	**Introduction in parallel computing** 1.1. Motivating parallelism: intensive-computing applications 1.2. Introduction of parallelism in computing architectures	2
2.	**Parallel architectures** 2.1. Classification depending on control and data streams 2.2. Classification depending on memory organization 2.3. Interconnection networks in parallel and distributed systems (static and dynamic networks)	2
3.	**Designing parallel algorithms** 3.1. Designing stages: data and computation partitioning, communication among tasks, tasks agglomeration, tasks mapping 3.2. Tasks dependencies analysis 3.3. Loop parallelization 3.4. Automatic parallelization 3.5. Examples: parallel algorithms design	6
4.	**Analysis and estimation of parallel algorithms performances** 4.1. Parallel algorithms asymptotic analysis and estimation 4.2. Parallel speedup – Amdahl's law 4.3. Cost-optimal algorithms 4.4. Examples: analysis and estimation of parallel algorithms	4
5.	**Programmimg parallel algorithms** 5.1. Classification of parallel programming techniques 5.2. Dynamic creation of processes and threads 5.3. Parallel programmind languages and libraries	2
6.	**Parallel programing using shared memory** 6.1. Synchronizations among threads and processes: mutexes, semaphores, monitors, condition variables,barriers, message queues 6.2 POSIC Pthread Library 6.3. OpenMP technology 6.4. Exemples: parallel algorithms in shared memory platforms	8
7.	**Parallel programming using message passing** 7.1. Message passing primitives 7.2. Message passing libraries: MPI, PVM 7.3. Exemples: parallel algorithms in message passing systems	4
	Total:	**28**

b. *Applications*:

Laboratory 1.	Programs development in Unix-Linux operating systems; processes and threads	4
Laboratory 2.	Parallel programming with Pthread Library	4
Laboratory 3.	OpenMP technology	4
Laboratory 4.	Parallel programming with MPI library	4

Laboratory 5.	Simple parallel algorithms: matrix operations	4
Laboratory 6.	Complex parallel algoritms: k-means clustering, Gaussian adnd Gauss-Jordan ellimination	4
Laboratory 7.	Laboratory evaluation	4
	Total:	**28**

5. ASSESSMENT

a) Activities assessed and their weighting:

Laboratory evaluation	40%
Examination during semester	20%
Final examination	40%

b) Minimum passing requirements:
According to the “**Graduating Regulations**”, scoring 50% out of evaluation of activities during the semester and 50% out of total is required.

c) Final scoring:
According to the “**Graduating Regulations**”, the final score is obtained rounding overall score, if minimal passing requirements are fulfilled.

6. BENCHMARKING

The lectures are presented at the blackboard and for some subjects multimedia facilities are used.

The laboratory documentation is available for the students in electronic form. The laboratory works are executed by practical programming at the computer (using languages and toolsets selected for each work) and interpretation of results. We recommend students to study the documentation before presentation in the laboratory room.

7. BIBLIOGRAPHY

- *Felicia Ionescu*: *Principiile Calculului Paralel*, Ed. Tehnică, Bucuresti, 1999.
- A. Grama, A. Gupta, G .Karypis, V. Kuma: *Introduction to Parallel Computing*, Addison Wesley, 2003.
- *Jan Foster*: *Designing and Building Parallel Programs*, An Online Publishing Project of Addison-Wesley Inc. and Argonne National Lab.
- *Posix Threads*, http://www.llnl.gov/computing/tutorials/ pthreads/
- *OpenMP Library*, http://www.openmp.org
- *MPI Standard*, http://www-unix.mcs.anl.gov/mpi
- Felicia Ionescu, Gabriel Dimitriu, Cristina Stoica, Valentin Stoica: *Indrumar de laborator de Calcul Paralel*

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