INSTITUTO POLITÉCNICO NACIONAL

SECRETARÍA ACADÉMICA

DIRECCIÓN DE EDUCACIÓN SUPERIOR

SINTHESIZED SCHOOL PROGRAM

ACADEMIC UNIT: Escuela Superior de Cómputo

ACADEMIC PROGRAM: Ingeniería en Sistemas Computacionales.

LEARNING UNIT: Analysis and Design of Parallel Algorithms **LEVEL:** III

AIM OF THE LEARNING UNIT:
The student develops parallel algorithms through parallel techniques.

CONTENT:

I. Introduction.
II. Basic algorithms.
III. Graphs algorithms.
IV. Expression algorithms.
V. Sorting algorithms.

TEACHING PRINCIPLES:
Teacher will apply a Projects-Based learning process, through heuristic and analogical methods using techniques such as: study cases, brainstorming, information search through information and communication technologies (ICT), analysis of data, cooperative work, graphic organizers, teacher led discussions, design of plans and/or experiments, technical reports, and oral communication.

EVALUATION AND PASSING REQUIREMENTS:
The program will evaluate the students using a learning portfolio which is integrated by:

- Formative and summative evaluation, rubrics, self-evaluation and cooperative evaluation rubric, and learning evidence.

Other ways to pass this Learning Unit:

- Evaluation of knowledge previously acquired with base in the issues defined by the academy.
- In other Academic Unit of the IPN.
- In other national or international academic undergraduate or graduate institution.

REFERENCES:

- Cassanova, H. Legrand, A. Yves, R. (2008). *Parallel Algorithms* (1ª Ed.). Estados Unidos de América: Ed. Chapman and Hall. ISBN: 978-1584889458.
- Gebali, F. (2011). *Algorithms and Parallel Computing* (1ª Ed.). Estados Unidos de América: Ed. Wiley. ISBN: 978-0470902103.
- JaJa, J. (1992). *Introduction to Parallel Algorithms* (1ª Ed.). Estados Unidos de América: Ed. Addison Wesley. ISBN: 978-0201548563.
- Kumar, V. Grama, A. Gupta, A. Karpis, G. (2003). *Introduction to Parallel Computing* (2ª Ed.). Estados Unidos de América: Ed. Addison Wesley. ISBN: 978-0201648652.
- Paul, J. L. Berman, K. A. (2004). *Algorithms: Sequential, Parallel and Distributed* (1ª Ed.). Estados Unidos de América: Course Technology. ISBN: 978-0534420574.

INSTITUTO POLITÉCNICO NACIONAL

SECRETARÍA ACADÉMICA

DIRECCIÓN DE EDUCACIÓN SUPERIOR

ACADEMIC UNIT: Escuela Superior de Cómputo.
ACADEMIC PROGRAM: Ingeniería en Sistemas Computacionales
LATERAL OUTPUT: Analista Programador de Sistemas de Información.
FORMATION AREA: Professional.
MODALITY: Presence.

LEARNING UNIT: Analysis and Design of Parallel Algorithms.
TYPE OF LEARNING UNIT: Theorical - Practical, Optative.
USE: August, 2011
LEVEL: lll.
CREDITS: 7.5 Tepic, 4.39 SATCA

ACADEMIC AIM

The program provides knowledge on parallel algorithms implementation; this implementation is according with parallel systems requirements. The students will work together in collaborative, tolerant, and respectful way; also, they will develop strategic thinking skills and creative. All this support to graduate profile with knowledge and skills to develop parallel algorithms that a Computational System Engineer has to know. This program has as antecedent Learning Units to: Operating Systems, Object Oriented Analysis and Design, Computing Networks, Software Engineering, Data Structures, Computer Architecture, and Applications to Communication on Networks.

AIM OF THE LEARNING UNIT:
The student develops parallel algorithms through parallel techniques.

CREDITS HOURS

THEORETICAL CREDITS / WEEK: 3.0

PRACTICAL CREDITS / WEEK: 1.5

THEORETICAL HOURS/SEMESTER: 54

PRACTICALS HOURS/SEMESTER: 27

AUTONOMOUS LEARNING HOURS: 54

CREDIT HOURS / SEMESTER: 81

LEARNING UNIT DESIGNED BY:
Academia de Sistemas Distribuidos.

REVISED BY:
Dr. Flavio Arturo Sánchez Garfias.
Subdirección Académica

APPROVED BY:
Ing. Apolinar Francisco Cruz Lázaro.
Presidente del CTCE

AUTHORIZED BY: Comisión de Programas Académicos del Consejo General Consultivo del IPN

Ing. Rodrigo de Jesús Serrano Domínguez
Secretario Técnico de la Comisión de Programas Académicos

THEMATIC UNIT: I **TITLE:** Introduction

UNIT OF COMPETENCE

The student analyzes the objective, characteristics and application of parallel algorithms based on their performance and optimization.

No.	CONTENTS	Teacher - led instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
1.1	Parallel algorithm definition.	1.0	0.5	0.5	1.0	2B,3B,6C
1.2	Parallel computation model.	1.5		1.0		
1.2.1	General techniques.					
1.2.2	Number of processors reduction.					
1.2.3	Parallel algorithms performance.					
1.3	Optimization.	0.5		0.5		
1.3.1	Optimization definition.					
1.3.2	Examples.					
1.4	Complexity of communication.	0.5		0.5		
	Subtotal:	3.5	0.5	2.5	1.0	

TEACHING PRINCIPLES

Course framing and team arrangement.
This Learning Unit will use Projects-Based learning strategy through heuristic and analogical methods with the follow techniques: study cases, information search and analysis, teacher led discussions, elaboration of concept maps in teams of four, and develop of practical 1 in team.

LEARNING EVALUATION

Diagnostic evaluation
Project Portfolio:

Worksheets	20%
Concept maps	60%
Practical reports	10%
Self-evaluation rubric	5%
Cooperative evaluation rubric	5%

THEMATIC UNIT: II **NAME:** Basic algorithms

UNIT OF COMPETENCE

The student implements basic parallel algorithms based on parallelization techniques.

No.	CONTENTS	Teacher - led instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
2.1 2.1.1 2.1.2 2.1.3 2.1.4 2.1.5 2.1.6 2.1.7 2.2	Basic techniques. Balanced trees. Jump pointer. Divide and conquer. Partitioning. Pipelining. Accelerated cascading. Symmetry breaking. Comparison of techniques.	3.0 1.0	0.5	3.5 1.0	4.0	1B,2B,3B
	Subtotal:	4.0	0.5	4.5	4.0	

TEACHING PRINCIPLES

This Learning Unit will use Projects-Based learning strategy through heuristic and analogical methods with the follow techniques: study cases, search and analysis of information, teacher led discussions, elaboration of concept maps in teams of four, develop of practical 2, 3 y 4 in team, and design of a project plan in teams of four where apply the knowledge and skills learned in this unit and the previous one.

LEARNING EVALUATION

Learning Portfolio:

Worksheets	20%
Concept maps	10%
Practice report	10%
Project plan design	50%
Self-evaluation rubric	5%
Cooperative evaluation rubric	5%

THEMATIC UNIT: III **NAME:** Graphs algorithms

UNIT OF COMPETENCE

The student implements lists and graph parallel algorithms based on parallelization techniques.

No.	CONTENTS	Teacher - led instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
3.1	Introduction.	0.5	0.5		8.5	1B,2B,3B,5C
3.2	Lists and trees.	1.0		3.5		
3.2.1	Ordered List.					
3.2.2	Euler tour technique.					
3.2.3	Parallel computing on trees.					
3.3	Graphs.	2.0		5.0		
3.3.1	Routes, expansion and contraction of trees.					
3.3.2	Connected Components.					
3.3.3	Minimum spanning tree.					
3.3.4	Eulerian circuits and maximum matching.					
3.3.5	Graph Coloring.					
3.3.6	Directed graphs.					
	Subtotal:	3.5	0.5	8.5	8.5	

TEACHING PRINCIPLES

This Learning Unit will use Projects-Based learning strategy through heuristic and analogical methods with the follow techniques: study cases, search and analysis of information, teacher led discussions, elaboration of concept maps in teams of four, develop of practical 5, 6 and 7 in team, and re-design of the project plan and development of the first part of the project where apply the knowledge and skills learned in this unit and the previous one.

LEARNING EVALUATION

Learning Portfolio:

Worksheets	20%
Concept maps	10%
Practice report	10%
Project advances report (first part)	25%
Written and oral presentation of the partial technical report	25%
Self-evaluation rubric	5%
Cooperative evaluation rubric	5%

THEMATIC UNIT: IV **NAME:** Expression algorithms

UNIT OF COMPETENCE

The student implements parallel algorithms for expression evaluation based on parallelization techniques.

No.	CONTENTS	Teacher - led instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
4.1	Introduction.	0.5	0.5		5.5	1B,2B,6C
4.2	Construction of an expression tree.	3.0		4.5		
4.2.1	Optimal parallel algorithm for the evaluation of expressions.					
4.2.2	Optimal parallel processing of regular expressions to nondeterministic finite automaton.					
4.2.3	Generalized expression evaluation.					
4.3	Efficient algorithms for dynamic programming.	1.5		3.0		
	Subtotal:	5.0	0.5	7.5	5.5	

TEACHING PRINCIPLES

This Learning Unit will use Projects-Based learning strategy through heuristic and analogical methods with the follow techniques: study cases, search and analysis of information, teacher led discussions, elaboration of concept maps in teams of four, develop of practical 8 and 9 in team, and re-design of the project plan and development of the second part of the project where apply the knowledge and skills learned in this unit and the previous one.

LEARNING EVALUATION

Project Portfolio:

Worksheets	20%
Concept maps	10%
Practice report	10%
Project advances report (second part)	25%
Written and oral presentation of the partial technical report	25%
Self-evaluation rubric	5%
Cooperative evaluation rubric	5%

THEMATIC UNIT: V **NAME:** Sorting algorithms

UNIT OF COMPETENCE

The student implements parallel sorting algorithms based on parallelization techniques.

No.	CONTENTS	Teacher - led instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
5.1	Introduction.	0.5	0.5		5.5	2B,3B,4C,5C
5.2	Sorting.	1.0		2.0		
5.2.1	Classical techniques.					
5.3	Sorting networks.	3.0		5.0		
5.3.1	Sorting networks of Batcher.					
5.3.2	Parallel optimal merge sorting of Cole.					
5.3.3	Theoretically optimal sorting networks.			2.0		
5.4	Borders to compare problems.	1.5				
	Subtotal:	6.0	0.5	9.0	5.5	

TEACHING PRINCIPLES

This Learning Unit will use Projects-Based learning strategy through heuristic and analogical methods with the follow techniques: develop of practical 10 and 11 in team, and development of the final part of the project where apply the knowledge and skills learned in this unit and the previous one.

LEARNING EVALUATION

Project Portfolio:

Practical reports	10%
Project delivery	50%
Written and oral presentation of the final technical report	20%
Learning evidence	10%
Self-evaluation rubric	5%
Cooperative evaluation rubric	5%

RECORD OF PRACTICALS

No.	NAME OF THE PRACTICAL	THEMATIC UNITS	DURATION	ACCOMPLISHMENT LOCATION
1	Basic techniques of parallelism	I	1.5	ESCOM Laboratories.
2	Balanced tree algorithm programming	II	1.5	
3	Accelerated cascade algorithm programming	II	1.5	
4	Symmetry breaking algorithm programming	II	1.5	
5	Euler tour technique programming	III	3.0	
6	Parallel computing on trees	III	3.0	
7	Eulerian circuits and maximum matching	III	3.0	
8	Programming parallel algorithm for the evaluation of expressions	IV	3.0	
9	Parallel processing of regular expressions to nondeterministic finite automaton	IV	3.0	
10	Sorting network of Batcher programming	V	3.0	
11	Algorithm merge of Cole programming	V	3.0	
		TOTAL OF HOURS	27.0	

EVALUATION AND PASSING REQUIREMENTS:

Practicals are 10% worth of the each thematic unit evaluation.

PERIOD	UNIT	EVALUATION TERMS
1	I and II	Continuous evaluation 100%
2	III and IV	Continuous evaluation 100%
3	V	Continuous evaluation 90% Learning evidence 10% The thematic unit I is 10% worth of the learning unit final score. The thematic unit II is 20% worth of the learning unit final score. The thematic unit III is 20% worth of the learning unit final score. The thematic unit IV is 25% worth of the learning unit final score. The thematic unit V is 25% worth of the learning unit final score. Other ways to pass this Learning Unit: • Evaluation of knowledge previously acquired with base in the issues defined by the academy. • In other Academic Unit of the IPN. • In other national or international academic undergraduate or graduate institution. If accredited by Special Assessment or a certificate of proficiency, this will be based on guidelines established by the academy on a previous meeting for this purpose.

KEY	B	C	REFERENCES
1	X		Cassanova, H. Legrand, A. Yves, R. (2008). *Parallel Algorithms* (1ª Ed.). Estados Unidos de América: Ed. Chapman and Hall. ISBN: 978-1584889458.
2	X		Gebali, F. (2011). *Algorithms and Parallel Computing* (1ª Ed.). Estados Unidos de América: Ed. Wiley. ISBN: 978-0470902103.
3	X		JaJa, J. (1992). *Introduction to Parallel Algorithms* (1ª Ed.). Estados Unidos de América: Ed. Addison Wesley. ISBN: 978-0201548563.
4		X	Kumar, V. Grama, A. Gupta, A. Karpis, G. (2003). *Introduction to Parallel Computing* (2ª Ed.). Estados Unidos de América: Ed. Addison WEsley. ISBN: 978-0201648652.
5		X	Paul, J. L. Berman, K. A. (1996). *Fundamentals of Sequential and Parallel Algorithms.* (1ª Ed.). Estados Unidos de América: Course Technology. ISBN: 978-0534946746.
6		X	Paul, J. L. Berman, K. A. (2004). *Algorithms: Sequential, Parallel and Distributed* (1ª Ed.). Estados Unidos de América: Course Technology. ISBN: 978-0534420574.

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SECRETARÍA ACADÉMICA

DIRECCIÓN DE EDUCACIÓN SUPERIOR

TEACHER EDUCATIONAL PROFILE PER LEARNING UNIT

1. GENERAL INFORMATION

ACADEMIC UNIT: Escuela Superior de Cómputo.

ACADEMIC PROGRAM: Ingeniería en Sistemas Computacionales. **LEVEL** III

FORMATION AREA:

Institutional	Basic Scientific	Professional	Terminal and Integration

ACADEMY: Sistemas Distribuidos. **LEARNING UNIT:** Analysis and Design of Parallel Algorithms.

SPECIALTY AND ACADEMIC REQUIRED LEVEL: Master degree in Computer Science.

2. AIM OF THE LEARNING UNIT:
The student develops parallel algorithms through parallel techniques.

3. PROFESSOR EDUCATIONAL PROFILE:

KNOWLEDGE	PROFESSIONAL EXPERIENCE	ABILITIES	ATTITUDES
• Parallel and distributed systems • Parallel algorithms. • Operating Systems. • Computer networks and networked applications. • C + + and Java programming. • UNIX and Windows systems programming. • Object-oriented design and UML. • MPI and multicore architectures expertise. • MEI. • English language.	• One year experience in teaching professional level education. • One year experience in the parallel and concurrent applications design and implementation.	• Able to analyze and synthesize. • Able to apply knowledge into practice. • Problem solving ability. • Team work and groups management.Leaders hip. • Able to apply the Institutional Educational Model.	• Responsable. • Tolerant. • Honest. • Respectful. • Collaborative. • Participative. • Interested to learning. • Assertive. • Academic vocation. • Social and institutional commitment

DESIGNED BY	REVISED BY	AUTHORIZED BY
M. en C. Jorge Cortés Galicia Profesor coordinador y/o colaborador	Dr. Flavio Arturo Sánchez Garfias Subdirector Académico	Ing. Apolinar Francisco Cruz Lázaro Director

Date: 2011