INSTITUTO POLITÉCNICO NACIONAL

SECRETARÍA ACADÉMICA

DIRECCIÓN DE EDUCACIÓN SUPERIOR

SYNTHESIZED SCHOOL PROGRAM

ACADEMIC UNIT: Escuela Superior de Cómputo

ACADEMIC PROGRAM: Ingeniería en Sistemas Computacionales

LEARNING UNIT: Unsupervised Neural Networks **LEVEL:** III

AIM OF THE LEARNING UNIT:
The student builds computer systems of information clustering and pattern classification based on Unsupervised Neural Networks technology.

CONTENTS:

I. Overview of Neural Networks.
II. Unsupervised learning rules.
III. Self-organized neural networks.
IV. Associative models.
V. Construction of unsupervised neural networks on programmable devices.

TEACHING PRINCIPLES:
The teacher will apply a Projects-Based learning process, through inductive and heuristic methods using analysis techniques, technical data, organization charts, cooperative presentation, exercise-solving and the production of the learning evidences. It will encourage teamwork and individual integrity and responsibility to the environment. Moreover, an autonomous learning will be encouraged by the development of a final project.

EVALUATION AND PASSING REQUIREMENTS:
The program will evaluate the students in a continuous formative and summative way, which will lead into the completion of learning portfolio. Some other assessing methods will be used, such as revisions, practical´s, class participation, exercises, learning evidences and a final project.

Unit Learning can also be approved through::

- Evaluation of acknowledges previously acquired, by developing a computer program and a written evidence of learning
- Official recognition by either another IPN Academic Unit of the IPN or by a national or international external academic institution besides IPN with a current cooperation a agreement.

REFERENCES:

- Demouth H., Beale M., Hagan M. (2009). Matlab Neural Network Toolbox 6 User´s Guide. The Matworks, Inc, USA. on line only (16/marzo/2011). www.mathworks.com/access/helpdesk/help/pdf_doc/nnet/nnet.pdf.
- Hagan, M. T. Demuth, H. B. Beale, M. (2002). *Neural Network Design*. USA: PWS Publishing Company. ISBN-13: 978-0534943325.
- Haykin, S. (2009). *Neural Networks and Learning Machines*. (3ª Edition). USA: Prentice Hall. ISBN: 13: 978-0-13-147139-9.
- Ham, F. M. Kostanic, I. (2001). *Principles of Neurocomputing for Science & Engineering*. New York USA: Mc Graw-Hill. ISBN 0-07-025966-6.
- Omondi A. R., Rajapakse J. C. (2006). FPGA Implementation of Neural Networks, Springer, Dordrecht, The Netherlands. ISBN -10: 0-387-28485-0 (HB)

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: Unsupervised Neural Networks.
TYPE OF LEARNING UNIT: Theorical - Practical, Optative.
VALIDITY: August, 2011
LEVEL: lll.
CREDITS: 7.5 Tepic, 4.39 SATCA

ACADEMIC AIM

This program contributes to the profile of graduated on Ingeniería en Sistemas Computacionales, to develop the skills to design computer systems based on unsupervised neural networks for solving computational problems in engineering related to the grouping of information and pattern classification, the ability to describe and to distinguish the major unsupervised network architectures, the ability to implement intelligent systems in integrated circuits, ability to design and simulate intelligent systems.

It also helps to develop generic skills such as strategic thinking, creative thinking, collaborative and participatory work, assertive communication, contributing to their integral development, so The student will be able to perform in different sectors of society, public private research and integrate and manage internal work teams and multidisciplinary with an attitude of leadership, ethics and responsibility. The student is continuously updated to meet the needs of society and sustainable development of the country

It is based on the programs of linear algebra, calculus, algorithms and structured programming, analysis and object-oriented design, and software engineering. It is related laterally to pattern recognition, artificial intelligence, genetic algorithms, Fuzzy Systems Engineering, Computational Intelligence in Control Engineering and Unsupervised Artificial Neural Networks. This supports subsequent to the learning units Terminal Work I and II.

AIM OF THE LEARNING UNIT:

The student builds computer systems of information clustering and pattern classification based on Unsupervised Neural Networks technology.

CREDITS HOURS

THEORETICAL CREDITS / WEEK: 3.0

PRACTICAL CREDITS / WEEK: 1.5

THEORETICAL HOURS / SEMESTER: 54

PRACTICAL HOURS / SEMESTER: 27

AUTONOMOUS LEARNING HOURS: 54

CREDITS HOURS / SEMESTER: 81

LEARNING UNIT DESIGNED BY:
Academia de Ingeniería de software.

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:** Overview of Neural Networks

UNIT OF COMPETENCE

The student classifies the fundamental concepts of unsupervised artificial neural networks based on the characteristics that define them.

No.	CONTENTS	Teacher led-Instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
1.1	Historical review of unsupervised artificial neural networks.	3.0	1.0	6.0	3.0	3B, 4B, 7B
1.2	Definitions of neural networks					
1.3	The biological neuron model.					
1.4	The artificial neural network model.					
1.5	General Characteristics of unsupervised neural networks.					
1.6	Applications of unsupervised neural networks.					
1.7	Types of unsupervised learning					
	Subtotals:	3.0	1.0	6.0	3.0	

TEACHING PRINCIPLES

This thematic unit must start in the frame of the course and team building. Thematic unit will be addressed through the strategy of project-based learning, using the inductive method; This unit uses learning techniques such as concept mapping, cognitive maps, worksheets, presentation of additional issues, development of practice and final project proposal.

LEARNING EVALUATION

Diagnostic Test

Project Portfolio:

Project proposal	5%
Graphic Organizers	5%
Documentary research	5%
Worksheet	5%
Exposure themes	10%
Report of Practical	20%
Self-Evaluation Rubrics	5%
Cooperative-evaluation Rubrics	5%
Written Learning Evidence	40%

THEMATIC UNIT: II **TITLE:** Unsupervised learning rules

UNIT OF COMPETENCE

The student classifies unsupervised learning algorithms based on the architecture of unsupervised Artificial Neural Networks

No.	CONTENTS	Teacher led-Instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
2.1	Unsupervised learning.	0.5		1.0		3B, 4B, 7B, 12B, 2C
2.1.1	Unsupervised learning Concept					
2.1.2	Unsupervised learning classes.					
2.1.3	Unsupervised network architectures.					
2.2	Associative learning.	2.0	0.5	3.0	2.0	
2.2.1	Associative learning concepts					
2.2.2	Simple associative network.					
2.2.3	Unsupervised Hebb rule.					
2.2.4	Hebb rule with decay.					
2.2.5	Instar rule.					
2.2.6	Kohonen rule.					
2.2.7	Outstar rule.					
2.2.8	Examples and exercises using the associative rules					
2.2.9	Associative rules simulation in Matlab / Neural Network Toolbox (NNT).					
2.3	Competitive learning.	1.5	1.0	3.0	2.0	
2.3.1	Concept of competitive learning.					
2.3.2	Simple competitive network.					
2.3.3	Examples and classification exercises using the simple competitive network					
2.3.4	Competitive network simulation in Matlab / NNT					
	Subtotales:	4.0	1.5	7.0	4.0	

TEACHING PRINCIPLES

This unit will be addressed through the strategy of project-based learning, using the inductive method also will be added concept mapping techniques, cognitive maps, exercises-solving, exposure of issues, development of practical programming algorithms, and advance final project.

LEARNING EVALUATION

Project Portfolio

Graphic Organizers	5%
Exercise delivery	5%
Exposure themes	5%
Report of Practical	20%
Program delivery	10%
Advance of the Project	5%
Self-Evaluation Rubrics	5%
Cooperative-evaluation Rubrics	5%
Written Learning Evidence	40%

THEMATIC UNIT: III **TITLE:** Self-organized neural networks

UNIT OF COMPETENCE

The student solves problems of information clustering and classification of complex patterns based on learning algorithms and architectures of self-organized neural networks.

No.	CONTENTS	HOURS Activities with Professor		HOURS Activities of Autonomous Learning		REFERENCES KEY
		T	P	T	P	
3.1	Learning Vector Quantization (LVQ)	1.0	0.5	2.0	1.5	3B, 4B, 7B, 12B, 2C, 10C,11C
3.1.1	General features LVQ network					
3.1.2	LVQ network architecture					
3.1.3	LVQ learning algorithm					
3.1.4	Main applications of the LVQ network					
3.1.5	LVQ classification exercises					
3.1.6	Simulation and training of the LVQ network in MATLAB /					
3.2	NNT	1.0	0.5	2.0	1.5	
3.2.1	The Kohonen self-organizing map (SOM).					
3.2.2	General features of the SOM.					
3.2.3	SOM architecture.					
3.2.4	SOM learning algorithm.					
3.2.5	Main Applications of SOM.					
3.2.6	Classification exercises using SOM.					
3.3	Simulation and training of SOM in MATLAB / NNT	1.0	0.5	2.0	1.0	
3.3.1	Adaptive Resonance Theory (ART)					
3.3.2	General features ART network					
3.3.3	ART network architecture					
3.3.4	ART learning algorithm					
3.3.5	Main applications of the ART network					
3.3.6	Classification exercises using ART					
3.4	Simulation and training of the ART network MATLAB / NNT	1.0		1.0		
3.4.1	Principal Component Analysis (PCA)					
3.4.2	PCA General features					
3.4.3	PCA Architecture					
3.4.4	PCA algorithms					
3.4.5	PCA Applications					
3.4.6	PCA exercises					
	Simulation of PCA					
	Subtotals:	4.0	1.5	7.0	4.0	

TEACHING PRINCIPLES

This unit will be addressed through the strategy of project-based learning, using the inductive method also will be added concept mapping techniques, cognitive maps, exercises-solving, exposure of issues, development of practical, programming algorithms, and advance final project.

LEARNING EVALUATION

Project Portfolio:

Graphic Organizers	5%
Exercise delivery	10%
Exposure themes	5%
Report of Practical	20%
Program delivery	10%
Advance of the Project	10%
Self-Evaluation Rubrics	5%
Cooperative-evaluation Rubrics	5%
Written Learning Evidence	30%

N° THEMATIC UNIT: IV **TITLE:** Associative models

UNIT OF COMPETENCE

The student solves optimization problems and the implementation of associative memories based on learning algorithms and architectures for unsupervised neural networks

No.	CONTENTS	Teacher led-Instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
4.1	Linear Associative Memory (LAM)	1.5	0.5	2.0	1.0	3B, 4B, 7B, 12B 2C,5C, 6C
4.1.1	LAM General features.					
4.1.2	LAM architecture.					
4.1.3	Learning algorithm.					
4.1.4	LAM applications.					
4.1.5	Pattern Recognition exercises					
4.1.6	LAM simulation and training					
4.2	Hopfield network	1.5	0.5	3.0	2.0	
4.2.1	Hopfield network general characteristics					
4.2.2	Hopfield network architecture.					
4.2.3	Hebbian learning algorithm.					
4.2.4	Hopfield network stability					
4.2.5	Main Applications of Hopfield network.					
4.2.6	Pattern classification exercises and Troubleshooting					
4.2.7	Optimization.					
4.3	Simulation and training of the Hopfield network in	1.0	0.5	2.0	1.0	
4.3.1	MATLAB / NNT					
4.3.2	Bidirectional Associative Memory (BAM)					
4.3.3	BAM general characteristics					
4.3.4	BAM architecture.					
4.3.5	Learning algorithm.					
4.3.6	BAM applications.					
	Pattern recognition exercises					
	BAM training simulation.					
	Subtotales:	4.0	1.5	7.0	4.0	

TEACHING PRINCIPLES

This unit will be addressed through the strategy of project-based learning, using the inductive method also will be added concept mapping techniques, cognitive maps, exercises-solving, exposure of issues, development of practical, programming algorithms, and advance final project.

LEARNING EVALUATION

Project Portfolio:

Graphic Organizers	5%
Exercise delivery	10%
Exposure themes	5%
Report of Practical	20%
Program delivery	10%
Advance of the Project	5%
Self-Evaluation Rubrics	5%
Cooperative-evaluation Rubrics	5%
Written Learning Evidence	30%

THEMATIC UNIT: V **TITLE:** Construction of unsupervised neural networks on programmable devices

UNIT OF COMPETENCE

The student designs unsupervised neural networks based on programmable devices.

No.	CONTENTS	Teacher led-Instruction HOURS		Autonomous Learning HOURS		REFERENCES KEY
		T	P	T	P	
5.1	Fundamentals of programmable devices.	0.5		1.0		1C, 8C, 9C,
5.1.1	Introduction.					
5.1.2	General Features					
5.1.3	Classification					
5.1.4	Overview of design and simulation tools.					
5.2	Fundamentals of embedded systems.	0.5		1.0		
5.2.1	Introduction.					
5.2.2	Definition.					
5.2.3	Features					
5.2.4	Examples of embedded systems					
5.3	Main architectures for self-monitoring neural network	2.0		2.0	2.5	
5.3.1	construction.					
5.3.2	Introduction.					
5.3.3	General Features.					
5.3.4	Unsupervised neural network construction.					
	Unsupervised neural network simulation					
5.4	Unsupervised Neural Network Implementation on Programmable Devices	2.0	1.5	3.0	2.5	
5.4.1	Unsupervised Neural Network design and simulation on programmable devices					
5.4.2	Dedicated design implementation.					
5.4.3	Soft-core implementation					
	Subtotales:	5.0	1.5	7.0	5.0	

TEACHING PRINCIPLES

This unit will be addressed through the strategy of project-based learning, using the inductive method also will be added concept mapping techniques, cognitive maps, exercises-solving, exposure of issues, development of practical, programming algorithms, and final project.

LEARNING EVALUATION

Project Portfolio:

Exposure themes	10%
Practice Report	20%
Program delivery	15%
Final project	30%
Self-Evaluation Rubrics	5%
Cooperative-evaluation Rubrics	5%
Written Learning Evidence	15%

RECORD OF PRACTICALS

No.	NAME OF THE PRACTICAL	THEMATIC UNITS	DURATION	ACCOMPLISHMENT LOCATION
1	Basic neural models.	I	4.0	Computer Labs.
2	Associative learning rules.	II	2.5	
3	Simple Competitive network.	II	3.0	
4	Kohonen self-organizing maps	III	2.0	
5	LVQ networks.	III	2.0	
6	Adaptive Resonance Theory.	III	1.5	
7	Associative Memories.	IV	5.5	
8	Implementation of Unsupervised Neural Networks on Programmable devices.	V	6.5	
		TOTAL OF HOURS	27.0	

EVALUATION AND PASSING REQUIREMENTS:

The practical are considered mandatory to pass this unit of learning.
The practical mean 20% in each thematic unit.
The practices contribute 20% of the final grade.

PERÍOD	UNIT	EVALUATION TERMS
1 2 3	I, II III, IV V	Continuous evaluation 60% and written learning evidence 40% Continuous evaluation 70% and written learning evidence 30% Continuous evaluation 85% and written learning evidence 15% The Learning unit I is 15% worth of the final score The Learning unit II is 15% worth of the final score The Learning unit III is 15% worth of the final score The Learning unit IV is 15% worth of the final score The Learning unit V is 40% worth of the final score Learning unit can also be approved through:: • Evaluation of acknowledges previously acquired, by developing a computer program and a written evidence of learning • Official recognition by either another IPN Academic Unit of the IPN or by a national or international external academic institution besides IPN agreement which has. If accredited by Special Assessment or a certificate of proficiency, this will include a practical part which contribute 50% of the grade and a theoretical part that will provide the remaining 50%, based on guidelines established by the academy.

KEY	B	C	REFERENCES
1		X	Chu, P. P. (2008). *FPGA Prototyping by VHDL Examples Xilinx Spartan-3 version*. USA: Wiley-Interscience. ISBN 10:-0470185317.
2		X	Demouth H., Beale M., Hagan M. (2009). *Matlab Neural Network Toolbox 6 User´s Guide*. The Matworks, Inc, USA. on line only (19/Nov/2009). *www.mathworks.com/access/helpdesk/help/pdf_doc/nnet/nnet.pdf*
3	X		Hagan M. T., Demuth H. B., Beale M. (2002) *Neural Network Design.* PWS Publishing Company. USA. 1-665. ISBN-10: 0971732108
4	X		Ham F. M., Kostanic I. (2001). *Principles of Neurocomputing for Science & Engineering.* Mc Graw-Hill, New York USA. 1-642. ISBN 0-07-025966-6.
5		X	Heaton J., (2008). *Introduction to Neural Networks for C#*, 2nd Edition, Heaton Research Inc. USA, 1-428. ISBN-10: 1604390093.
6		X	Heaton J., (2008) *Introductions of Neural Networks for Java*, 2nd Edition, Heaton Research Inc. USA, 1-440. ISBN-10: 1604390085
7	X		Haykin S. (2009). *Neural Networks and Learning Machines*; 3ª Edition. Prentice Hall, USA. 1-936. ISBN-10: -0-13-147139-2.
8		X	Omondi A. R., Rajapakse J. C. (2006). *FPGA Implementation of Neural Networks*, Springer, Dordrecht, The Netherlands, 1- 360. ISBN -10: 0-387-28485-0 (HB).
9		X	Pedroni V. A. (2004). *Circuit Design with VHDL*, MIT Press, Massachusetts USA, 1-363. ISBN 0-262-16224-5.
10		X	Principe J., Euliano N. R. Lefebvre C. W. (1999). *Neural and Adaptive Systems: Fundamentals through Simulations*, Wiley & Sons, USA 1-672. ISBN-10: 0471351679.
11		X	Principe J., Lefebvre C., Lynn G, Fancourt C., Wooten D..; *Neurosolutions Getting Started Manual version 5*, NeuroDimension, Inc, USA 2006, on line (19/Nov/2009). *http://www.neurosolutions.com/downloads/documentation.html*
12	X		Reed R. D., Marks II R. J., (1999). *Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks*, The MIT Press, USA, 1-352. ISBN-10: 0262181908
13		X	Zell A., Mamier G., Vogt M. et all; (1995). *Stuttgart Neural Network Simulator User Manual, version 4.2*; University of Stuttgart, Germany, , 1-350. on line (19/Nov/2009). http://www.ra.cs.uni-tuebingen.de/SNNS/UserManual/UserManual.html.

INSTITUTO POLITÉCNICO NACIONAL

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: Ingeniería de software. **LEARNING UNIT:** Unsupervised Neural Networks.

SPECIALTY AND ACADEMIC REQUIRED LEVEL: Master or PhD. in Computer Science or Electrical Engineering

2. AIM OF THE LEARNING UNIT:

The student builds computer systems of information clustering and pattern classification based on Unsupervised Neural Networks technology.

3. PROFFESSOR EDUCATIONAL PROFILE:

KNOWLEDGE	PROFESSIONAL EXPERIENCE	ABILITIES	APTITUDES
• Concepts and learning algorithms of neural networks. • Techniques for design and simulation of neural networks. • Settlement Pattern classification problems. • Function approximation using neural networks • Knowledge of the Institutional Educational Model. • English.	• One year experience in the design of systems based on neural networks • Two years experience in handling groups and collaborative work • A year experience in the Institutional Educational Model.	• Analysis and synthesis. • Leadership. • Decision making. • Conflict Management. • Group management. • Verbal fluency of ideas. • Teaching Skills • Applications of Institutional Educational Model.	• Responsible. • Tolerant. • Honest. • Respectful. • Collaborative. • Participative. • Interested to learning. • Assertive.

DESIGNED BY	REVISED BY	AUTHORIZED BY
M en C. José Luis Calderón Osorno COORDINATING PROFESOR M en C. Edmundo René Durán Camarillo DR. Luz Noé Oliva Moreno M en C. Ignacio Ríos de la Torre. COLLABORATING PROFESSORS	Dr. Flavio Arturo Sánchez Garfias Subdirector Académico	Ing. Apolinar Francisco Cruz Lázaro Director

Date: 2011