



FACULDADE DE  
CIÊNCIAS E TECNOLOGIA  
UNIVERSIDADE NOVA DE LISBOA



# PhD Program In Electrical and Computer Engineering

(3rd Cycle – Bologna model)

## SYLLABUS

2008/2009

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### Year 1: COURSES

Scientific Research Methodologies and Techniques  
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Advanced Topics in Collaborative Networks  
Advanced Topics in Robotics and Integrated Manufacturing  
Advanced Topics in Industry Information Systems  
Advanced Topics in Telecommunications  
Advanced Topics in Computational and Perceptual Systems

Free option

### Years 2 to 4: THESIS DEVELOPMENT

## Year 1: COURSES

### COURSE: SCIENTIFIC RESEARCH METHODOLOGEIS AND TECHNIQUES

2008/2009

#### Summary of objectives:

This course aims at introducing the base concepts and methods of scientific research. The students will be guided on issues such as preparation of technical papers, preparation of the thesis, intellectual property, ethical principles in science, and research roadmapping and management. Finally, the preparation of a research project proposal is also exercised.

**Responsible professors:** Luis M. Camarinha-Matos

**Other professors involved:** Rita Ribeiro, Rui Neves Silva, Ricardo Gonçalves

#### DETAILED PROGRAM

##### Unit 1: INTRODUCTION

Objectives for a PhD, base concepts, types of research, relationship with supervisor

##### Unit 2: SCIENTIFIC METHOD

Overview of research methods, steps of the scientific method, engineering research

##### Unit 3: LITERATURE REVISION

Information sources, information search, special sources, synthesis and critics

##### Unit 4: PUBLICATION OF RESULTS

Writing scientific papers, publication channels, evaluation procedures, citations

##### Unit 5: THESIS ORGANIZATION AND VALIDATION

Structure, research question, thesis contribution, validation of results

##### Unit 6: RESEARCH IN COLLABORATION

Types of projects and partnerships, requirements, collaboration spirit and constraints

##### Unit 7: PROJECT PROPOSAL PREPARATION (1)

General structure of a proposal, typical example

##### Unit 8: PROJECT PROPOSAL PREPARATION (2)

Examples in different programs – EC, ESA, national

##### Unit 9: RESEARCH PROJECT MANAGEMENT

Management structure, management principles, tools, risks, reporting

##### Unit 10: ASSESSMENT OF RESEARCH RESULTS

Phases of research and outcomes, research performance indicators

##### Unit 11: RESEARCH ETHICS

Ethical issues and behavior, responsible conduct, scientific practices and violation

##### Unit 12: INTELLECTUAL PROPERTY RIGHTS

Concepts, types, protection mechanisms, rights identification, rights transfer

##### Unit 13: ROADMAPPING AND FUTURE PLANNING (1)

Future planning objectives and approaches, concept of roadmapping

##### Unit 14: ROADMAPPING AND FUTURE PLANNING (2)

Roadmapping methodology

##### Unit 15: PANEL

#### MODUS OPERANDI:

The course will comprise a set of lectures (2 h per unit) followed by work assignments to be performed by the students.

#### EVALUATION PROCEDURE

##### *Evaluation method:*

1. Preparation of a technical paper (acting as an author).
2. Evaluation of a technical paper (acting as a referee).
3. Preparation of a research project proposal in response to a national or European Call for proposals.

##### *Professors responsible for the evaluation:*

L. M. Camarinha-Matos, R. Ribeiro, R. Neves Silva, R. Gonçalves

## COURSE: ENTREPRENEURSHIP METHODS

2008/2009

### Summary of objectives:

This unit aims to offer students base skills in entrepreneurship methods and strategies with particular emphasis on innovation management and productization of research results.

**Responsible professors (coordination):** José Barata, Luis M. Camarinha-Matos

**Other professors involved:** Invited experts (external and internal to UNL) for each topic.

The course includes 15 Units of 2 h each, followed by practical work to be done by the PhD candidates.

### Unit 1: R&D, TECHNOLOGICAL EVOLUTION AND ECONOMIC GROWTH

Introduction to innovation.

Knowledge diffusion and productivity.

Technology management and commercialization. Innovation management.

### Unit 2: ENTREPRENEURSHIP ACTIVITIES

Introduction to entrepreneurship.

Technology and its impact in the modern world.

Overview of the technological and industrial evolution.

### Unit 3: NEEDED ENTERPRISE FUNCTIONS

Finances. Marketing. Human resources management. Production.

### Unit 4: STRATEGIC PLANNING AND BUSINESS PLAN (1)

### Unit 5: STRATEGIC PLANNING AND BUSINESS PLAN (2)

### Unit 6: MARKETING AND NEW TECHNOLOGIES

### Unit 7: MARKET STRUCTURES AND INCENTIVES TO INNOVATION

Risk capital. Business angels. Industrial promotion policies. Entrepreneurship support structures.

### Unit 8: INCUBATORS AND TECHNOLOGICAL PARKS

### Unit 9: PRODUCTIZATION OF RESEARCH RESULTS

### Unit 10: INTELLECTUAL PROPERTY (1)

Protection schemes.

### Unit 11: INTELLECTUAL PROPERTY (2)

Intellectual property roadmap.

### Unit 12: MANAGEMENT OF CREATIVITY

### Unit 13: INNOVATION IN NETWORKS

Collaborative networks and innovation. Users' involvement in co-innovation processes.

### Unit 14: CASE STUDIES (1)

Case 1.

### Unit 15: CASE STUDIES (2)

Case 2.

Case 3.

### MODUS OPERANDI:

The course will comprise a set of lectures (2 h per unit) followed by work assignments to be performed by the students.

### EVALUATION PROCEDURE

#### *Evaluation method:*

1. Select promising research results from a recently finished (or ongoing) research project. Elaborate a plan for impact creation / exploitation of those results.
2. Participate in the competition "Learn to be an entrepreneur".

*Professors responsible for the evaluation:* J. Barata, P. Sousa, J. Goes

## COURSE: DOCTORAL CONFERENCE

2008/2009

### Summary of objectives:

This unit is organized as a set of activities for the preparation and realization of a Winter or Summer School with a strong involvement of the candidates in all associated phases, and corresponds to an important mechanism to provide both scientific and soft skills.

Candidates will acquire skills on all aspects of preparation and running of scientific events. They will also exercise their presentation and intervention skills and share experiences with other PhD candidates. Through a series of selected keynote lectures the students will also get a better awareness of the current trends and challenges in their area of research. The conference, in all its phases, will also offer an important opportunity for social and professional networking.

**Responsible professors:** Luis M. Camarinha-Matos, Luis Gomes, Ricardo Gonçalves

**Other professors involved:** All PhD supervisors

### DETAILED PROGRAM

#### Unit 1: Conference preparation

- Tutorials on the basics of conference planning and organization
- Scientific program preparation
- Organizational logistics
- Dissemination and support seeking

#### *Modus operandi:*

- 3 tutorial sessions introducing summarizing the needs and mechanisms.
- Organization of a list of tasks to be performed by the students, under supervision of the responsible professors (task forces)
- Organization of a series of periodic meetings where task forces report their progress and next steps are discussed.

#### Unit 2: Conference realization

- The conference will run during 3 or 5 days, tentatively scheduled for October 2009.
- Sessions will include:
  - Tutorials by invited experts on scientific, methodological, or soft skills topics.
  - Presentation and discussion of the base ideas of the thesis plans.
  - Discussion of the scientific and technical challenges in the several Electrical and Computer Engineering specialization areas.
  - Sharing of experiences among PhD students from different geographical regions.
  - Forum on practical aspects (e.g. Publications, job market, careers, etc.).
  - Creation of collaborative (social) networks.

#### *Modus operandi:*

- Plenary and parallel track sessions
- PhD students to have an active involvement in the logistics of the event.

#### Unit 3: Synthesis and assessment

- Brief synthesis of the technical / scientific findings in the conference.
- Assessment of the operational aspects.

#### *Modus operandi:*

- Preparation of a report by the PhD candidates after the conference.

### EVALUATION PROCEDURE

#### *Evaluation method:*

Elements to be considered in the evaluation:

- Performance of the preparatory tasks
- Contribution to the technical content of the conference
- Assessment report

*Professors responsible for the evaluation:* L. M. Camarinha-Matos, L. Gomes, R. Gonçalves

### OTHER GUIDANCE

The conference will be open to PhD students from other universities.

The possibility of publishing the proceedings as a book by an international publisher is encouraged. Similarly the possibility of organizing special issues of journals (ranked in the Science Citation Index) shall be pursued.

## COURSE: RESEARCH PLANNING

2008/2009

### Summary of objectives:

This unit is devoted to the preparation of the Thesis Plan including definition of the research question(s) and its motivation, analysis and synthesis of the state of the art, and planning of the research activities.

ECTS: 30

**Responsible professors:** Coordinator of PhD Program

**Other professors involved:** All PhD supervisors

### DETAILED ACTIVITIES

Work Unit 1: Analysis of the state of the art and elaboration of a synthesis clearly identifying the current challenges. Special emphasis is put on the production of added value by the student.

Work Unit 2: Elaboration of the work plan for the 2nd phase of the PhD Program, including:

- Definition of objectives (research questions) and their motivation.
- Definition of the approach, methods and tools to be adopted.
- Preliminary identification of the potential contributions and their putting in context, including intermediate results.
- Definition of the activity plan and its scheduling.

Work Unit 3: Elaboration of the thesis validation strategy and plan.

Work Unit 4: Elaboration of the plan for dissemination and validation in the scientific community.

Work Unit 5: Integration of the research plan into the activities of the host research group.

Work Unit 6: Integration, if planned, of the activities in a national or international project.

Work Unit 7: Preparation of a report and public presentation and defense of the Thesis Plan.

### THESIS PLAN – REPORT STRUCTURE

A typical table of contents will include:

Abstract
1.Introduction / background
2.Research question and general approach
3.Literature review
4.Research methodology
a. Aimed contribution
b. Detailed work plan and scheduling
c. Validation methodology
d. Dissemination plan
e. Integration with other research activities
5.References

Size: 35 to 60 pages.

### EVALUATION PROCEDURE

- Presentation for the Thesis Accompanying Committee in a seminar (open to the public).
- Private discussion between the Committee and the candidate.

## COURSE: ADVANCED TOPICS IN CONTROL AND DECISION

2008/2009

### Summary of objectives:

The research activity on the scientific area of control and decision requires basic knowledge in a number of key topics:

- Dynamic behaviour of linear and non linear systems
- Optimization and optimal control
- System modelling
- Stability and robustness analysis

Advanced Topics in Control and Decision aims to provide the students the ability to use these tools on the development of their research activity.

**Responsible professors:** Fernando Coito

**Other professors involved:** Luís Palma, Paulo Gil.

### DETAILED PROGRAM

#### Unit 1: Linear Systems

- Modelling and mathematical representation.
- Time and frequency analysis.
- Controllability and Observability of LTIS.
- Controller design.
- Asymptotic observers and state reconstruction

*Recommended bibliographic references:*

Ribeiro, M. I., 2002. *Análise de Sistemas Lineares*, IST Press. ISBN 9728469136

- Chen, C. T., 1999. *Linear system theory and design*, Oxford University Press. ISBN 0195117778

*Contact professor for this topic:* Luís Palma (lbp@fct.unl.pt)

#### Unit 2: Optimal Control

- Formulation of optimal control problems
- Continuous time optimal control using the variational approach
- Fixed final time
- The linear quadratic regulator
- Terminal constraints, input constraints and path constraints problems
- Minimum time problems
- Discrete-time optimal control
- Computational optimal control
- Introduction to dynamic programming

*Recommended bibliographic references:*

- Athans, M. and Falb, P. L., 2006. *Optimal Control: An Introduction to the Theory and Its Applications*. Dover Publications. ISBN 0486453286
- Lewis, F. L., and Syrmos, V. L., 1995. *Optimal Control*, John Wiley & Sons. ISBN 0471033782

*Contact professor for this topic:* Paulo Gil (psg@fct.unl.pt)

#### Unit 3: Adaptive Control:

- Basic deterministic theory of LQ and predictive control
- Deterministic receding horizon control
- State estimation and system identification
- Linear Quadratic and predictive stochastic control
- Adaptive control

*Recommended bibliographic references:*

- Astrom, K.J. and Wittenmark, B., 2008. *Adaptive Control*, Dover Publications. ISBN 0486462781
- Ljung, L., 1999. *System Identification - Theory For the User*, PTR Prentice Hall. ISBN 0136566952
- Mosca, E., 1995. *Optimal, Predictive and Adaptive Control*, Prentice Hall.  
<http://www.dsi.unifi.it/~mosca/Main.pdf>

*Contact professor for this topic:* Fernando Coito (fjvc@fct.unl.pt)

### EVALUATION PROCEDURE

*Evaluation method:*

During the course the student will prepare a number of written essays, to be evaluated.

*Professors responsible for the evaluation:* F. Coito, P. Gil, L. Palma

## COURSE: ADVANCED TOPICS IN ELECTRONICS

2008/2009

### Summary of objectives:

The main objective of this course is to provide the attendees all required background in the design of Integrated Circuits (ICs) deep submicron (nano-scale) CMOS technologies (e.g. equations, advanced modeling and noise analysis) and in advanced topologies of the main building blocks used in most of RF and base-band electronic circuits (LNAs, PAs, Oscillators, Mixers, Amplifiers and Comparators). All important issues such as low-voltage and low power design techniques will be addressed. Practical design examples (front-end design) assisted by advanced CAD tools will be provided.

**Responsible professors:** João Goes.

**Other professors involved:** Nuno Paulino and Luis B. Oliveira.

### DETAILED PROGRAM

#### Unit 1: CMOS Technology, Transistor Equations and Noise (3 x 2H)

- CMOS technology
- Transistor's equations and operating regions
- Noise analysis

*Recommended bibliographic references:*

- Slides
- Chapters from the book: Yannis Tsividis, "(Operation and Modeling of) The MOS Transistor", 2<sup>nd</sup>. Edition, 2003, Oxford Press.

*Contact professor for this topic:* N. Paulino ([nunop@uninova.pt](mailto:nunop@uninova.pt))

#### Unit 2: Transistor Models, optimization and CAD tools (3 x 2H)

- LEVEL 2, BSIM and EKV modeling
- Design methodologies and Circuit Optimizers
- Simulation Tools. Layout Tools. Verification Tools
- Practical examples involving Tools

*Recommended bibliographic references:*

- Slides
- Chapters from the book: Yannis Tsividis, "(Operation and Modeling of) The MOS Transistor", 2<sup>nd</sup>. Edition, 2003, Oxford Press

*Contact professor for this topic:* J. Goes ([jg@uninova.pt](mailto:jg@uninova.pt))

#### Unit 3: Advanced CMOS Amplifier and Comparator Topologies (3 x H)

- Amplifier basics and basic building-blocks
- Advanced amplifier topologies
- CMOS Comparators

*Recommended bibliographic references:*

- Slides
- Chapters from the book: Willy Sansen "Analog Design Essentials", Springer.

*Contact professor for this topic:* J. Goes ([jg@uninova.pt](mailto:jg@uninova.pt))

#### Unit 4: Low-Noise Amplifiers (LNAs) and Power Amplifiers (PAs) (3 x 2H)

- Introduction to RF CMOS Design
- LNA topologies. PA topologies

*Recommended bibliographic references:*

- Slides
- Chapters from the book: G. Gonzalez, "Microwave Transistor Amplifiers", 2<sup>nd</sup>. Edition, Prentice Hall.

*Contact professor for this topic:* L. B. Oliveira ([l.oliveira@fct.unl.pt](mailto:l.oliveira@fct.unl.pt))

#### Unit 5: Oscillators and Mixers (3 x 2H)

- Advanced RF CMOS Oscillators. Mixers
- A practical example
- Measurement related issues in RF CMOS testing

*Recommended bibliographic references:*

- Slides
- Chapters from the book: G. Gonzalez, "Microwave Transistor Amplifiers", 2<sup>nd</sup>. Edition, Prentice Hall.

*Contact professor for this topic:* L. B. Oliveira ([l.oliveira@fct.unl.pt](mailto:l.oliveira@fct.unl.pt))

### EVALUATION PROCEDURE

*Evaluation method:*

A final work related with Units 3, 4, and 5 with a short (1 hour) defence plus an "American Style" (1.5 hour) exam covering the subjects of all 5 units.

*Professors responsible for the evaluation:* J. Goes, N. Paulino, L. B. Oliveira

## COURSE: ADVANCED TOPICS IN ENERGY

2008/2009

### Summary of objectives:

To provide advanced knowledge in research and project skills in the area of Electrical Engineering.

**Responsible professors:** A. Leão Rodrigues, M. Ventim Neves, João Martins, Stan Valtchev

### DETAILED PROGRAM

#### Unit 1: Mathematical methods for electromagnetic fields resolution

- Study of numerical methods for problem resolution in Electrical Engineering with particular emphasis on electrical machines and power transmission lines.

##### *Recommended bibliographic references:*

- Binns, Lawrenson, Trowbridge: The analytic and Numerical Solution of Electric and Magnetic Fields; Wiley, 1995
- Bastos, Sadowski: Electromagnetic Modeling by Finite Elements Method; Marcel Dekker, Inc, 2003
- Golub/van Loan: Matrix Computation; John Hopkins University Press, 1996
- Morton, Mayers: Numerical Solution of Partial Differential Equations; Cambridge University Press, 2005

*Contact professor for this topic:* Prof. M. Ventim Neves

*Contact professor for this topic:* M. Ventim Neves

#### Unit 2: Generalized Electrical Machines

- Two axis theory for electrical machines modeling. Park equations.

##### *Recommended bibliographic references:*

- B. M. Weddy ; B. J. Cory: Electric Power Systems, John Wiley & Sons, 1998
- Chee-Mun Ong: Dynamic Simulation of Electric Machinery, Prentice Hall Ptr, 1997
- J. Hindmarsh: Electrical Machines and Their Applications, Pergamon Press, 1997
- Benard Adkins: The General Theory of Electrical Machines, Chapman and Hall, 1964

*Contact professor for this topic:* A. Leão Rodrigues

#### Unit 3: Superconductivity in Energy Systems

- Properties of High Temperature Superconductors and their applications in energy systems (electrical machines, fault current limiters, energy storage-SMES))

##### *Recommended bibliographic references:*

- Anant Narlikar (Ed.): Studies of High Temperature Superconductors (Advances in Research and Applications), Vol. 32, Nova Science Publishers, 2000.
- G. Krabbes, G. Fuchs, W.-R. Canders, H. May, R. Palka: High Temperature Superconductor Bulk Materials (Fundamentals – Processing – Properties Control – Application Aspects), Wiley-VCH, 2006.

*Contact professor for this topic:* A. Leão Rodrigues

#### Unit 4: Diagnosis in Electrical Machines

- Mathematical methods to diagnosis faults in electrical machines (Park vector application)

##### *Recommended bibliographic references:*

- A. J. M. Cardoso (1991); Diagnóstico de avarias em motores de indução trifásicos, Coimbra editor, Coimbra, Portugal.
- P. Vas (1993); Parameter estimation, conditioning monitoring and diagnosis of electrical machines, Clarendon Press, Oxford, UK.
- P. J. Tavner, J. Penman (1987); Conditioning monitoring of electrical machines, RSP, Letchworth, Hertfordshire, UK.

*Contact professor for this topic:* J. Martins

#### Unit 5: Soft-switching power converters and resonant converters

- Power converters for contactless transfer of energy. Achieving the maximum efficiency (and maximum power factor) in energy conversion.

##### *Recommended bibliographic references:*

- Kazimierczuk, M., D. Czarkowski, Resonant Power Converters, John Wiley & Sons, Inc., New York, 1995
- Kurs, A., A. Karalis, R. Moffatt, J. Joannopoulos, P. Fisher, M. Soljačić, Wireless Power Transfer via Strongly Coupled Magnetic Resonances, Science 6 July 2007, no. 5834, pp. 83-86

*Contact professor for this topic:* S. Valtchev

### EVALUATION PROCEDURE

*Evaluation method:* Writing reports on these units.

*Professors responsible for the evaluation:* M. Ventim Neves, J. Martins, S. Valtchev

### OTHER GUIDANCE

Subjects are given in tutorial basis. Students are asked to contact personally the professor of each unit.

## COURSE: ADVANCED TOPICS IN SIGNAL PROCESSING

2008/2009

### Summary of objectives:

1 - In facing a concrete situation, the student must, by mere observation, to know how to extract some qualitative characteristics from the signal at hand, namely, those referent to periodic/non-periodic, deterministic/random and frequential occupation, in order to decide which analysis and modeling tools are suitable to use.

2 - To use, with skill, a) the suitable analyze methods, namely, those of spectral analysis; b) creation of linear models, chiefly, autoregressive.

3 - To know how to use and design linear systems which allow separate signals into simpler components to become easier their study and processing.

**Responsible professors:** Manuel Ortigueira

**Other professors involved:** Fernando Coito

### DETAILED PROGRAM

#### Unit 1: Revision of basic concepts

- Discrete-time signals
- Discrete-time linear invariant linear systems.
- Difference equations

#### *Recommended bibliographic references:*

- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2<sup>nd</sup> edition, Prentice-Hall, 2002.
- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4<sup>th</sup> edition, Prentice-Hall, 2006.

*Contact professors for this topic:* M. Ortigueira, F. Coito

#### Unit 2: The Fourier Analysis

- DFT and FFT

#### *Recommended bibliographic references:*

- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2<sup>nd</sup> edition, Prentice-Hall, 2002.
- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4<sup>th</sup> edition, Prentice-Hall, 2006.

*Contact professors for this topic:* M. Ortigueira, F. Coito

#### Unit 3: The Z Transform

- Definition
- Convergence.
- Properties.
- Inversion.

#### *Recommended bibliographic references:*

- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2<sup>nd</sup> edition, Prentice-Hall, 2002.
- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4<sup>th</sup> edition, Prentice-Hall, 2006.

*Contact professors for this topic:* M. Ortigueira, F. Coito

#### Unit 4: Introduction to Stochastic Processes

- Definition
- Main characteristics.
- Parameter estimation: mean, variance, and correlation.

#### *Recommended bibliographic references:*

- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2<sup>nd</sup> edition, Prentice-Hall, 2002.
- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4<sup>th</sup> edition, Prentice-Hall, 2006.

*Contact professors for this topic:* M. Ortigueira, F. Coito

#### Unit 5: Spectral Analysis

- Blackmann-Tukey and Bartlett-Welch methods.
- High resolution methods: Capon, Min-Norm and MUSIC
- Multiwindow methods.

*Recommended bibliographic references:*

- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2nd edition, Prentice-Hall, 2002.
- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Prentice-Hall, 2006.

*Contact professors for this topic:* M. Ortigueira

Unit 6: Linear Prediction

- Estimation methods: correlation, covariance and Burg.
- Ladder/lattice structures.
- Applications: speech coding and spectral analysis.

*Recommended bibliographic references:*

- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Prentice-Hall, 2006.
- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2nd edition, Prentice-Hall, 2002.

*Contact professors for this topic:* M. Ortigueira

Unit 7: Advanced topic (to choose according to the particular interests of students):

- Adaptive Algorithms. Applications: noise and echo canceling; adaptive equalization.
- Filters: structures and characteristics. Special Filters. Realization.
- Multirate Conversion.
- The ARMA model. Parameter Estimation.
- Adaptive array signal processing.
- Wavelet Transform.
- Time-Frequency Distributions.

*Recommended bibliographic references:*

- Proakis, J. G. e Manolakis, D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Prentice-Hall, 2006.
- Ifeachor, E., C., Jervis, B., W., "Digital Signal Processing: A Practical Approach", 2nd edition, Prentice-Hall, 2002.

*Contact professors for this topic:* M. Ortigueira, F. Coito

**EVALUATION PROCEDURE**

*Evaluation method:*

- a) The assessment will consist of the realization of a project.
- b) This project can be in group, but will have an individual evaluation.

*Professors responsible for the evaluation:* M. Ortigueira, F. Coito and another Professor from the DEE with interests on the Signal Processing area.

**OTHER GUIDANCE**

There will be several texts and software available at the page of the discipline.

## COURSE: ADVANCED TOPICS IN COLLABORATIVE NETWORKS

2008/2009

### Summary of objectives:

This unit intends to give an updated overview of the current state of the art and research challenges in Collaborative Networks. First a general understanding of the scope of this new scientific discipline and its manifestations is aimed at. Then, a general understanding of the state of the art, current implementation practices, and research challenges shall be acquired.

**Responsible professor:** Luis M. Camarinha-Matos

**Another professor involved:** Celson Lima

### DETAILED PROGRAM

#### Unit 1: COLLABORATIVE NETWORKS - INTRODUCTION

- Overview
- Examples
- Classes

##### *Recommended bibliographic references:*

- Slides VE2, VE3
- Chapter 2.3 of Book 2.
- Camarinha-Matos, L. M. (2008). Advances in collaborative networked organizations. Proceedings of BASYS'08, 23-25 Jun 08, Porto, Portugal, Innovation in Manufacturing Networks (A. Azevedo, Ed.), Springer, pp. 3-16.

#### Unit 2: ICT INFRASTRUCTURES FOR COLLABORATION

- Infrastructure and services
- Approaches – layered, service-oriented, agent-based, grid computing
- Security and privacy, cryptography, VPN, e-Notary
- Access rights, biometric solutions, agent passport

##### *Recommended bibliographic references:*

- Slides VE4, VE5
- Chapters 5.1, 5.2 of Book 1.
- Camarinha-Matos, L.M. (2004). ICT Infrastructures for VO. In Virtual Organizations – Systems and Practice, Springer.

#### Unit 3: VO BREEDING ENVIRONMENTS

- Concept and typology
- Reference framework
- VBE management
- Value systems, benefits, trust

##### *Recommended bibliographic references:*

- Slides VE6
- Chapters 2.1, 2.2, 2.3, 2.4 of Book 1

#### Unit 4: VIRTUAL ORGANIZATIONS

- VO creation process and approaches
- VO creation framework
- Negotiation support
- VO management, DBP modeling and management
- Performance management, inheritance

##### *Recommended bibliographic references:*

- Slides VE7, VE8
- Chapters 2.5, 2.6, 3.1, 3.2, 3.3 of Book 1

#### Unit 5: INTERACTION WITH CUSTOMERS

- Direct – EDI, STEP, etc.
- Meeting point - Portals
- E-Market
- Co-innovation

##### *Recommended bibliographic references:*

- Slides VE9
- Albrecht, C.C.; Dean, D.L.; Hansen, J. V. (2005). Marketplace and technology standards for B2B e-commerce: progress, challenges, and the state of the art. Information & Management, Volume 42, Issue 6, Pages 865-875.

Unit 6: e-COMMERCE

- Concept and differences regarding CN
- Main issues and approaches
- Payment process, risks
- Auctions, e-procurement
- M-commerce

*Recommended bibliographic references:*

- Slides VE10
- Tarasewich, P.; Nickerson, R.C.; Warkentin, M. (2002). Issues in mobile e-commerce. Communications of the Association for Information Systems (Volume 8, 2002) 41-64.
- Harrison McKnight, D.; Choudhury, V.; Kacmar, C. (2003). Developing and Validating Trust Measures for e-Commerce: An Integrative Typology. Information Systems Research, Vol. 13, No. 3, September 2002.

Unit 7: VIRTUAL COMMUNITIES AND SOCIAL NETWORKS

- Overview
- Examples
- Classes

*Recommended bibliographic references:*

- Slides VE11
- Chapters 4.1, 4.2, 4.3 of Book 1.

Unit 8: REFERENCE MODELS

- Modeling framework
- ARCON reference model

*Recommended bibliographic references:*

- Slides VE12
- Book 2

**GENERAL BIBLIOGRAPHY**

- Slides VE2-VE12 – Powerpoint presentations used in the Virtual Enterprises course
- Books:
  1. Camarinha-Matos, L. M.; Afsarmanesh, H.; Ollus, M. (Editors) (2008). Methods and tools for Collaborative Networked Organizations, ISBN 978-0-387-79423-5, Springer: New York.
  2. Camarinha-Matos, L. M.; Afsarmanesh, H. (2008). Collaborative Networks: Reference Modeling, Springer: New York, ISBN 978-0-387-79425-9.

**EVALUATION PROCEDURE**

*Evaluation method:*

Elaboration of a brief monograph discussing the applicability of this scientific domain to the area of work of the PhD candidate and identifying what would be the main R&D challenges for development of Collaborative Networks in that context.

*Professors responsible for the evaluation:*

Luis M. Camarinha-Matos, Celson Lima

## **COURSE: ADVANCED TOPICS IN ROBOTICS AND INTEGRATED MANUFACTURING**

**2008/2009**

### **Summary of objectives:**

This unit intends to give an updated overview of the current state of the art and research challenges in integrated and intelligent manufacturing systems. Recent progress and challenges on advanced robotics and interaction between humans and machines are also covered.

**Responsible professors:** Luis M. Camarinha-Matos

**Other professors involved:** José Barata, Yves Rybarczyk, C. Lima

### **DETAILED PROGRAM**

#### Unit 1: Agile and Reconfigurable Manufacturing Systems

- Motivation and determining factors
- Architectures
- Current challenges

#### *Recommended bibliographic references:*

- Babiceanu, R.F., & Chen, F.F. (2006). Development and Applications of Holonic Manufacturing Systems: A Survey. *Journal of Intelligent Manufacturing* 17(1), 111-131.
- Barata, J. (2005). Coalition Based Approach For ShopFloor Agility. Edições Orion, Amadora - Lisboa.
- ElMaraghy, H.A. (2006). Flexible and Reconfigurable Manufacturing Systems Paradigms. *International Journal of Flexible Manufacturing Systems* 17(4), 261-276.
- Bi, Z.M., Lang, S.Y.T., Shen, W., & Wang, L. (2008). Reconfigurable manufacturing systems: the state of the art. *International Journal of Production research* 46(4), 967-992.

*Contact professor for this topic:* J. Barata

#### Unit 2: Agent Based Manufacturing

- Revision of MAS concepts
- SoA of MAS applied to Manufacturing

#### *Recommended bibliographic references:*

- Barata, J. (2005). Coalition Based Approach For ShopFloor Agility. Edições Orion, Amadora - Lisboa.
- Monostori, L., Váncza, J., & Kumara, S.R.T. (2006). Agent-Based Systems for Manufacturing. *CIRP Annals* 55(2).
- Olsen, S., Wang, J., Ramirez-Serrano, A., & Brennan, R.W. (2005). Contingencies-based reconfiguration of distributed factory automation. *Robotics and Computer Integrated Manufacturing* 21, 379-390.
- Jammes, F., & Smit, H. (2005). Service-oriented paradigms in industrial automation. *IEEE Transactions on Industrial Informatics* 1(1), 62-70.

*Contact professor for this topic:* J. Barata, L. M. Camarinha-Matos

#### Unit 3: Intelligent Supervision and Self-healing systems

- Execution supervision and system supervision
- Machine learning
- Self-healing systems

#### *Recommended bibliographic references:*

- Amin, M. (2001). Toward self-healing energy infrastructure systems. *Computer Applications in Power*, IEEE, Volume: 14, Issue: 1, pp 20-28.
- Camarinha-Matos, L.M. (2008). Intelligent Supervision – course notes, UNL.

*Contact professor for this topic:* L. M. Camarinha-Matos, C. Lima

#### Unit 4: Collaborative networks of machines and sensors

- Principles of collaborative networks
- Examples of collaborating machines
- Sensor networks

#### *Recommended bibliographic references:*

- Akyildiz, I. F.; Su, W.; Sankarasubramaniam, Y.; Cayirci, E. (2002). A Survey on Sensor Networks. *IEEE Communications Magazine* • August 2002, pp 102-114.
- Kitano, H.; Asada, M.; Kuniyoshi, Y.; Noda, I.; Osawa, E. (1997). RoboCup: The Robot World Cup Initiative. *Proceedings of the first international conference on Autonomous agents*, Marina del Rey, California, USA, Pages: 340 – 347.

- Camarinha-Matos, L. M. (2008). Advances in collaborative networked organizations. Proceedings of BASYS'08, 23-25 Jun 08, Porto, Portugal, Innovation in Manufacturing Networks (A. Azevedo, Ed.), Springer, pp. 3-16.

Contact professor for this topic: L. M. Camarinha-Matos, J. Barata

**Unit 5:** Self-Organization and Emergence to Support Evolvable Production Systems

- Bio-inspired mechanisms
- Self-organization and Emergence
- Current solutions and challenges

*Recommended bibliographic references:*

- Pfeifer, R., Lungarella, M., & Iida, F. (2007). Self-Organization, Embodiment, and Biologically Inspired Robotics. *Science* 318, 1088-1093.
- Kari, L., & Rozenberg, G. (2008). The Many Facets of Natural Computing. *Communications of the ACM* 51(10), 72-83.
- Tharumarajah, A. (2003). A Self-organising View of Manufacturing Enterprises. *Computers in Industry* 51(2), 185-196.
- Deguet, J., L. Magnin, et al. (2007). "Emergence and Software development Based on a Survey of Emergence Definitions." *Studies in Computational Intelligence* 56: 13-21.
- De Wolf, T. (2007). Analysing and Engineering Self-Organising Emergent Applications. *Computer Science Department*, Kath. Univ. Leuven. PhD Thesis.

Contact professor for this topic: J. Barata, L. M. Camarinha-Matos

**Unit 6:** Autonomous intelligent robots

- Modeling approaches
- Service robots

*Recommended bibliographic references:*

- Brooks, R. (2008). I, Rodney Brooks, Am a Robot. *IEEE Spectrum* 45(6): 68-71
- Franceschini, N., Ruffier, F. & Serres, J. (2007). A Bio-Inspired Flying Robot Sheds Light on Insect Piloting Abilities. *Current Biology* 17(4): 329-335
- Pfeifer, R., Lungarella, M., & Iida, F. (2007). Self-Organization, Embodiment, and Biologically Inspired Robotics. *Science* 318, 1088-1093.
- Kari, L., & Rozenberg, G. (2008). The Many Facets of Natural Computing. *Communications of the ACM* 51(10), 72-83.
- Pfeifer, R., & Scheier, C. (2001). Understanding intelligence. MIT Press, Cambridge, MA.
- Roy, N.; Baltus, G.; Fox, D.; Gemperle, F.; Goetz, J.; Hirsch, T.; Margaritis, D.; Montemerlo, M.; Pineau, J.; Schulte, J.; Thrun, S. (2000). Towards Personal Service Robots for the Elderly. Workshop on Interactive Robots and Entertainment (WIRE). Pittsburgh, PA.

Contact professor for this topic: Y. Rybarczyk, J. Barata

**Unit 7:** Human-machine interaction

- Ergonomic aspects
- Balanced automation systems
- Human-machine interface
- Virtual reality and extended reality
- Affective computing

*Recommended bibliographic references:*

- Kennedy, P., Andreassen, D., Ehirim, P., King, B., Kirby, T., Mao, H. & Moore, M.(2004). Using human extra-cortical local field potentials to control switch. *J Neural Eng* 1(2): 72-77
- Picard, R. W. (2003). Affective computing: challenges. International Journal of Human-Computer Studies, Volume 59, Issues 1-2, July 2003, Pages 55-64.
- Pantic, M.; Pentland, A.; Nijholt, A.; Huang, T.S. (2007). Human Computing and Machine Understanding of Human Behavior: A Survey. Lecture Notes in Computer Science, Volume 4451/2007, pp 47-71.
- Fong, T.; Nourbakhsh, I.; Dautenhahn, K. (2003). A survey of socially interactive robots. Robotics and Autonomous Systems, Vol. 42, Issues 3-4, pp 143-166.

Contact professor for this topic: Y. Rybarczyk, L. M. Camarinha-Matos

**EVALUATION PROCEDURE**

*Evaluation method:*

Based on a written assignment and its oral defense. Examples:

- 1) Prepare a synthesis of current research challenges in the various topics; or
- 2) Considering your past professional experience in this area, summarize the most promising new directions and discuss their applicability.

*Professors responsible for the evaluation:* L. M. Camarinha-Matos, J. Barata, Y. Rybarczyk

## COURSE: ADVANCED TOPICS IN INDUSTRY INFORMATION SYSTEMS

2008/2009

### Summary of objectives:

This unit aims at providing an overview of the current state of the art and trends in information systems frameworks, architectures and technologies applied to industry. Modeling, management and access, exploitation and integration of information are addressed. A special attention is devoted to soft modeling and reasoning approaches.

**Responsible professors:** PhD Program coordinator

**Other professors involved:** Luis M. Camarinha-Matos, José Barata, Ricardo Gonçalves, Rita Ribeiro, Pedro Sousa, Yves Rybarczyk.

### DETAILED PROGRAM

#### Unit 1: TRENDS IN INFORMATION SYSTEMS

- Data modeling techniques in Engineering - overview
- Distributed and Federated Information Systems
- Multimedia Information Systems
- Intelligent contents

#### *Recommended bibliographic references:*

- Garita, C.; Afsarmanesh, H.; Hertzberger, L.O. (2001). The PRODNET Federated Information Management Approach for Virtual Enterprise Support. *Journal of Intelligent Manufacturing*, Vol. 12, Issue 2.
- Afsarmanesh, H.; Guevara, V.; Hertzberger, L.O. (2004). Federated management of information for TeleCARE. *Proceedings of TELECARE 2004 - Int. Workshop on Tele-Care and Collaborative Virtual Communities in Elderly Care*. INSTICC Press.
- Kosch, H. & Döllner, M. (2005). *Multimedia Database Systems: Where are we now?* IASTED DBA. Innsbruck, Austria.
- Heesch, D. & Rüger, S. (2004). *NNk Networks for Content-Based Image Retrieval*. CIVR. Dublin, Ireland.
- Wang, Y.; Liu, Z.; Huang, J.-C. (2000). Multimedia content analysis: Using both audio and visual clues. *IEEE Signal Processing Magazine*, Volume: 17, Issue: 6.
- Camarinha-Matos, L.M. Data modeling in engineering – course notes.  
<http://www.uninova.pt/~cam/mde/mde.doc>

*Contact professor for this topic:* L. M. Camarinha-Matos, Y. Rybarczyk

#### Unit 2: COMPUTATIONAL INTELLIGENCE AND QUALITATIVE REASONING

- Computational intelligence methods
- Qualitative modeling and reasoning
- Decision support

#### *Recommended bibliographic references:*

- Pedrycz, W. and F. Gomide (2007). *Fuzzy Systems Engineering- Toward Human-Centric Computing*, John Wiley & Sons.
- Ross, T. (2004). *Fuzzy Logic with Engineering Applications*, John Wiley & Sons.
- Chen, Z. (2000). *Computational Intelligence for Decision Support*, CRC Press.
- Li, H. X. and V. C. Yen (1995). *Fuzzy sets and fuzzy decision making*, CRC Press.
- Bellman, R. E. and L. A. Zadeh (1970). "Decision-Making in a Fuzzy Environment." *Management Science* Vol.17(No.4): 141-164.
- Zadeh, L. A. (1965). "Fuzzy Sets." *Information and Control* 8: 338-353.
- Yoon, K. P. and C.-L. Hwang (1995). *Multiple attribute decision making*, Sage Publications

*Contact professor for this topic:* L. M. Camarinha-Matos, R. Ribeiro

#### Unit 3: KNOWLEDGE DISCOVERY AND DATA MINING

- Principles of machine learning
- Other data mining algorithms
- Data pre-processing and standards

#### *Recommended bibliographic references:*

- K. Cios, W. Pedrycz, R. Swiniarski, L. Kurgan, *Data Mining: A Knowledge Discovery Approach*, Springer, 2007.
- Hastie, T., R. Tibshirami, et al. (2001). *The Elements of Statistical Learning*. Data Mining, Inference and Prediction, Springer.
- Berson, A. and S. J. Smith (1997). *Data warehousing, data mining & OLAP*, McGraw-Hill.

- Chen, Z. (2001). Data Mining and Uncertain Reasoning - An Integrated Approach, John Wiley & Sons.
- Cios, K. J., W. Pedrycz, et al. (1998). Data Mining Methods for Knowledge Discovery, Kluwer.
- Mitchell, Tom. Machine Learning, McGraw Hill, 1997.
- Fayyad, U. M. , Piatetsky-Shapiro, G., Smyth, P., Uthurusamy, R. Advances in Knowledge Discovery and Data Mining, AAAI Press/ The MIT press, 1996

Contact professor for this topic: R. Ribeiro, P. Sousa

#### Unit 4: SYSTEMS INTEGRATION

- Integration needs, levels, and challenges
- Reference architectures and frameworks.
- Approaches and technologies

Recommended bibliographic references:

- Chen, D., Doumeingts, G., & Vernadat, F. (2008). Architectures for enterprise integration and interoperability: Past, present and future. *Computers in Industry* 59(7), 647-659.
- Panetto, H., & Molina, A. (2008). Enterprise integration and interoperability in manufacturing systems: Trends and issues. *Computers in Industry* 59(7), 641-646
- Camarinha-Matos, L.M.; Afsarmanesh, H. (2003). Designing the information technology subsystem, invited chapter, in Handbook on Enterprise Architecture, P. Bernus, L. Nemes, G. Schmidt (Eds.), Springer, 2003, pp. 617-680, ISBN 3-540-00343-6.

Contact professor for this topic: J. Barata, L. M. Camarinha-Matos

#### Unit 5: ENTERPRISE INTEROPERABILITY

- Data morphisms, model morphisms and transformations
- Semantic harmonization and adaptability
- New methods and tools for interoperability of complex systems

Recommended bibliographic references:

- Enterprise Interoperability III: New Challenges and Industrial Approaches, Kai Mertins, Rainer Ruggaber, Keith Popplewell, Xiaofei Xu; Springer; ISBN: 978-1848002203, June 2008
- Journal of Intelligent Manufacturing, special issue on "E-Manufacturing and Web-Based Technology for Intelligent Manufacturing and Networked Enterprise Interoperability", Panetto, Hervé and Jardim-Gonçalves, Ricardo and Pereira, Carlos, eds. Vol. 17 (6). pp. 639-640. ISSN 0956-5515, 2006.
- Ontologies in the Context of Information Systems; Sharman, Raj and Kishore, Rajiv and Ramesh, Ram; Springer; ISBN 978-0-387-37019-4, 2006
- Exploring complexity; Gregoire Nicolis, Ilya Prigogine; Freeman, ISBN 071671859-6, 1989

Contact professor for this topic: R. Gonçalves

#### **EVALUATION PROCEDURE**

*Evaluation method:*

Elaboration of a synthesis (style "related-work") identifying the typical problems addressed by each area and open research challenges.

*Professors responsible for the evaluation:* L. M. Camarinha-Matos, R. Ribeiro, J. Barata, R. Gonçalves, P. Sousa, Y. Rybarczyk.

## COURSE: ADVANCED TOPICS IN TELECOMMUNICATIONS

2008/2009

### Summary of objectives:

The objective of this course is to provide complementary formation with respect to the PhD thesis.

Therefore, a specific syllabus will be defined for the profile of each student.

For the scholar year of 2008/09 the syllabus will most likely cover routing mechanisms.

The scope of the study is medium to large networks that need dynamic routing, but do not form yet an Internet. The study will focus on the efforts to provide multi-path routing.

**Responsible professors:** Paulo da Fonseca Pinto

**Other professors involved:** Luis Bernardo, Rui Dinis

### DETAILED PROGRAM

#### Unit 1: Introduction

- Basic concepts for routing
- Main protocols with practical use
- The structure of the Internet
- Routing in mobile environments

#### *Recommended bibliographic references:*

- Tanenbaum, "Computer Networks", 4th ed, Prentice-Hall, 2003
- S. Halabi "Internet Routing Architectures" (2nd Edition), Cisco Press ISBN-10: 1-57870-233-X; ISBN-13: 978-1-57870-233-6
- L. Subramaniam, M. Caesar, C. Ee, M. Handley, M Mao, S. Shenker, I Stoica, "HLP: A next Generation Inter-domain Routing Protocol", SIGCOMM'05, Philadelphia
- Changling Liu, Jorg Kaiser, "A survey on mobile ad hoc networks routing protocols", University of Magdeburg, 2005
- Royer, E., Toh, C. (April 1999). "A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks". IEEE Personal Communications 6 (2): 46-55. doi:10.1109/98.760423

*Contact professor for this topic:* P. Fonseca Pinto, L. Bernardo, R. Dinis

#### Unit 2: Calculus for routing protocols

- Study of various approaches

#### *Recommended bibliographic references:*

- João Luís Sobrinho, "An Algebraic Theory of Dynamic Network Routing", IEEE/ACM Transactions on Networking, Vol. 13, No. 5, October 2005
- Timothy G. Griffin, João Luís Sobrinho, "Metarouting" ACM SIGCOMM Computer Communication Review Volume 35, Issue 4 October 2005

*Contact professor for this topic:* P. Fonseca Pinto, L. Bernardo, R. Dinis

#### Unit 3: The challenges of multi-path routing

- Study of various approaches
- Trade-offs between network structure and construction of structures

#### *Recommended bibliographic references:*

- J. He and J. Rexford, "Toward Internet-Wide Multipath Routing", IEEE Network • March/April 2008
- N. Wang, K. Ho, G. Pavlou, and M. Howarth, "An Overview Of Routing optimization For Internet Traffic Engineering" IEEE Communications Surveys & Tutorials • 1st Quarter 2008

*Contact professor for this topic:* P. Fonseca Pinto, L. Bernardo, R. Dinis

### EVALUATION PROCEDURE

#### *Evaluation method:*

Writing of an essay.

*Professors responsible for the evaluation:* P. Fonseca Pinto, L. Bernardo, R. Dinis

## **COURSE: ADVANCED TOPICS IN COMPUTATIONAL AND PERCEPTIONAL SYSTEMS**

**2008/2009**

### **Summary of objectives:**

Acquisition of advanced knowledge on topics related to the development of computational and perceptual systems, including modeling of complex evolutionary systems with learning capability, perceptual sub-systems (e.g. image processing with Artificial Intelligence techniques), and computational models and supporting technologies for embedded systems.

**Responsible professor:** Adolfo Steiger Garção

**Other professors involved:** Luís Gomes, José Manuel Fonseca, Ricardo Gonçalves, Pedro Sousa, João Paulo Pimentão

### **DETAILED PROGRAM**

#### Unit 1: Structure and dynamics of complex systems

- Behavior of adaptative systems
- Modeling adaptation in evolutionary systems
- Complex systems monitoring and interoperability checking
- Analysis of transitory, feedback and prognosis
- New methods and tools for complex systems interoperability

#### *Recommended bibliographic references:*

- Enterprise Interoperability III: New Challenges and Industrial Approaches, Kai Mertins, Rainer Ruggaber, Keith Popplewell, Xiaofei Xu; Springer; ISBN: 978-1848002203, June 2008
- Thinking in Complexity: The Computational Dynamics of Matter, Mind, and Mankind; Autor: Klaus Mainzer; Springer-Verlag; ISBN: 3-540-60637-8, 2007
- Systems Thinking, Second Edition: Managing Chaos and Complexity: A Platform for Designing Business Architecture; Autor: Jamshid Gharajedaghi; Ano: 2005; Butterworth-Heinemann; ISBN-13: 978-0750679732
- Chaos and Nonlinear Dynamics: An Introduction for Scientists and Engineers; Autor: Robert Hilborn; Ano: 2001; Oxford University Press; ISBN-13: 978-0198507239
- General Systems Theory: Foundations, Development, Applications; Autor: Ludwig von Bertalanffy; Ano: 1969; GEORGE BRAZILLER; ISBN-13: 978-0-8076-0453-3

*Contact professor for this topic:* R. Gonçalves, A. Steiger Garção

#### Unit 2: Modeling formalisms for embedded systems

- Model-driven approaches
- Models of computation
- Behavioral models for developing embedded systems
- Behavioral formalisms within selected application areas

#### *Recommended bibliographic references:*

- Axel Jantsch; Modeling Embedded Systems and SoC's: Concurrency and Time in Models of Computation, Morgan Kaufmann, 2003. ISBN-10: 1558609253. ISBN-13: 978-1558609259.
- Stephen A. Edwards; Languages for Digital Embedded Systems; Kluwer Academic Publishers; 2000, ISBN-10: 0-7923-7925-X
- C. Girault, R. Valk; Petri Nets for Systems Engineering: A Guide to Modeling, Verification, and Applications, Springer-Verlag, 2002, ISBN: 3-540-41217-4
- Richard Zurawski (Ed.); Embedded systems handbook; CRC Press; 2006, ISBN-10: 0-8493-2824-4, ISBN-13: 978-0-8493-2824-4

*Contact professor for this topic:* L. Gomes

#### Unit 3: Knowledge Discovery and Data Mining

- Business Intelligence/Intelligent Systems/Data Warehousing/Data Mining
- Data Mining problems and techniques
- Inputs and output data, Data pre-processing, Data Quality, Results quality
- Learning Methods (Classification/Regression, Segmentation, Association)
- Discussion Problems (Ethics and privacy in data mining, Standardization of Techniques in data mining, Dealing with multiple data sources: time and space problems)

#### *Recommended bibliographic references:*

- Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, The Morgan Kaufmann Series in Data Management Systems, Jim Gray, Series Editor, Morgan Kaufmann Publishers, August 2000. ISBN 1-55860-489-8.
- Daniel T. Larose, "Discovering Knowledge in Data: An Introduction to Data Mining", 2004, Wiley-InterScience, ISBN: 978-0-471-66657-8
- Zhengxin Chen, Data Mining and Uncertain Reasoning, October 2001, John Wiley & Son, ISBN: 978-0-471-38878-4

- Ian H. Witten and Eibe Frank. Data Mining: Practical Machine Learning Tools and Techniques (Second Edition). Morgan Kaufmann, San Mateo, CA, June 2005, ISBN 0-12-088407-0.
- Machine Learning, Tom Mitchell, McGraw Hill, 1997, ISBN 0070428077

Contact professor for this topic: P. Sousa, J. P. Pimentão

#### Unit 4: Image Processing

- Image Enhancement in the Spatial Domain
- Image Enhancement in the Frequency Domain
- Image Restoration and Registration Techniques
- Color Image Processing
- Wavelets and Multiresolution Image Processing
- Image Compression
- Intelligent methods for symbolic image interpretation

#### *Recommended bibliographic references:*

- Rafael C. Gonzalez and Richard E. Woods: Digital Image Processing (3<sup>rd</sup>. Ed.). Prentice Hall 2008. ISBN 9780131687288.
- Rafael C. Gonzalez and Richard E. Woods: Digital Image Processing Using MATLAB. Prentice Hall 2004. ISBN 0130085197
- J. Parker: Algorithms for Image Processing and Computer Vision. John Wiley and Sons (1996). ISBN 0471140562
- John C. Russ and J. Christian Russ: Introduction to Image Processing and Analysis. CRC Press (2007). ISBN 0849370736.
- Tom Mitchell: Machine Learning, McGraw Hill (1997). ISBN 0070428077

Contact professor for this topic: J. M. Fonseca

#### Unit 5: Other approaches in perception

- Survey of trends in sensorial systems.
- Perception architectures.
- Machine learning techniques applied to sensorial systems.
- New sensorial technologies and materials.
- Reconfigurability issues in wireless sensor nodes
- Health applications.

#### *Recommended bibliographic references:*

- Enrico Coiera. Guide to Health Informatics. Arnold Publishers; 2003. ISBN 0340 764252.
- Richard Zurawski (Ed.); Embedded systems handbook; CRC Press; 2006, ISBN-10: 0-8493-2824-4, ISBN-13: 978-0-8493-2824-4
- Tom Mitchell, Machine Learning, McGraw Hill, 1997. Creed Huddleston, Intelligent Sensor Design Using the Microchip Dspic. Newnes. ISBN13: 9780750677554
- Feng Zhao, Leonidas Guibas. Wireless Sensor Networks: An Information Processing Approach. 2004. The Morgan Kaufmann Series in Networking.

Contact professor for this topic: José Manuel Fonseca, Luis Gomes

### **EVALUATION PROCEDURE**

#### *Evaluation method:*

Based on a written assignment and its oral defense.

Example: Prepare a synthesis of current research challenges in the various topics.

*Professors responsible for the evaluation:* A. S. Garção, L. Gomes, J.M. Fonseca, R. Gonçalves, P. Sousa, J. P. Pimentão

## **COURSE: FREE OPTION**

This unit is aimed at extending the specific scientific background of the candidate and can be selected from any other course (or set of courses totaling 6 ECTS) from the MSc or PhD programs offered by FCT/UNL or any other university, subject to approval by the Scientific Committee of the PhD Program.

Examples may include courses in the Mathematics area (e.g. Logic, Automata Algebraic Theory, Simulation and Numerical Computation, Statistical Inference, etc.), or Engineering area (e.g. Forecasting Techniques, Data Analysis and Simulation in Environment, etc.), etc.

## Years 2 to 4: THESIS DEVELOPMENT

After the courses component, the students will develop the research work proposed in their Thesis Plan, including the thesis writing, for a period of up to 3 years (minimum 2 years).

This work will be conducted by the PhD candidate under guidance of his/her supervisor.

During the first year, a supervisor is appointed for each student by the Scientific Commission of the Program, in accordance with the candidate. The supervisor must be a professor or researcher with a PhD and experienced in conducting research work in the area of the aimed thesis. When the supervisor is external, a co-supervisor will also be appointed.

The topic of the thesis shall be proposed by the supervisor, as early as possible, during the first year of the Program. The topic must be registered according to the legislation, namely the artº 32º of the Law nº 74/2006.

The thesis can be written in English or Portuguese, with an abstract in both languages.

After a favorable recommendation from the Thesis Accompanying Committee, the thesis is submitted as a preliminary version. The thesis evaluation committee, nominated by the Rector under proposal of the Scientific Council of the FCT-UNL, might suggest changes / improvements, after which the candidate shall submit the final version to be discussed in a public examination.

This syllabus will be revised annually.