University School of Computer Science. TECHNICAL UNIVERSITY OF MADRID				
Postgraduate Program in Computer Science and Information Technology				
Course	Syllabus	ECTS	Type	Semester
Trends in Artificial Intelligence	Objectives: The objective of the course is to provide an up-to-date view of the field of Artificial Intelligence, its most important methods and their possibilities of application to computer systems. Description: State space exploration. Heuristics Search. Machine learning. Decision trees. Bayesian techniques. Case-based Learning. Pattern recognition. Classical algorithms. Support Vector Machines. Clustering. Soft Computing evaluation methods. RRNN. Evolutionary Computing. Fuzzy Logics. Intelligent agents. Ontologies.	4	M	1
Distributed Systems	Objectives: The objective of this course is to teach the student fundamental concepts of synchronization and communication processes in distributed computing environments. In these environments the processes do not share clocks and must communicate each other using messages through interconnection with different qualities of service networks. We will show two abstractions to achieve this objective: passage of messages and distributed shared memory. Description: Introduction to the different models of distributed systems. Synchronization of clocks and global state. Inter-process communication: passage of messages and radiated with qualities of service. Communication with distributed shared memory	4	M	1
Innovation as a Tool for Software Product Development	Objectives: It is to provide students with the basic theoretical and practical knowledge which is necessary to be able him/her to integrate innovation within both software development and software intensive products. Description: The current context of the development of software products and intensive products in software. Agility and innovation in process. Design and implementation of agile processes. Introduction of	4	M	1

	innovation in processes. Innovation in a releases-driven system. Competitions of innovation. Introduction of the concepts of agility and innovation in an organization.			
Research Seminars	Objectives: The objective of the conferences is to illustrate, by leader researchers, the most important advances in scientific and technical areas. Description: Lectures by prestigious researchers about recent advances in the field.	3	M	2
State of the Art in Science and Computer Technology Research	Objectives: The objective of this course is to update students with those recent research works related to the master itself and supported by the university researching group. Description: Presentation of recent research in Computer Sciences and Technologies, highlighting the most relevant ones, as well as the analysis of current trends in research.	6	M	1
Advanced Distributed Systems	Objectives: One of the objectives of this course is to offer the student coordination concepts for failures in distributed systems. Another objective is to study the fault tolerance of the data delivered by using transactions. Description: Introduction to the different models of distributed systems. Detection failures. Consensus. Leader election. Centralized transaction. Distributed transaction. Transactions with data replication.	4	O	2
Modeling and Analysis of Systems	Objectives: Modeling of biological processes. Analysis of systems modeled by using abstract mathematical techniques. Usage and interpretation of the results of mathematical model analyses. Numerical implementation of the models. Design and interpretation of predictions by using differential equations models. Description: Modeling of biological and industrial processes by means of differential equations systems. Analysis of the proposed systems and numerical simulations.	4	O	2

Unconventional Models of Computation	Objectives: Introducing the students to unconventional computing models that can become engines for technological developments in the future. Teaching students to design and implement architectures and algorithms in the different models studied. Description: DNA-based computing: definition, basic concepts, models and basic experiments. Computing with membranes and NEPs: definition, basic models, models based on active membranes, tissue-like P systems. NEPs: definition, basic models, simulations. Quantum computing: definition of the model, basic algorithms, Grover's algorithm, quantum Fourier, Shor algorithm, quantum cryptography, protocol BB84, quantum cryptography security.	6	O	1
Digital Signal, Voice and Image Processing	Objectives: To train the student for the multidisciplinary analysis of problems that are related to signal digital processing (SDP) with emphasis on the study of voice signals and images. Description: Discrete Fourier transform. FFT algorithm of fast transform. Application of FFT algorithm to the design of digital filters. Interpolation based on the efficient FFT convolution. Fast multiplication algorithms based on FFT. Introduction to SDP. Transforms. Filtering. Sounds and phonetics production. The ear and the perception of voice. Time and frequency analysis techniques. Synthesis. Voice encoding. Recognition of voice and speakers. Two-dimensional signals. Images. Image digital processing. DNA microarrays image processing. Statistical processing of microarray genetic information.	6	O	1
Simulation of Communication Networks	Objectives: It is becoming more necessary to design communication networks that are robust against models of traffic demand as well as fault-tolerant. Researchers are aware of the importance of developing techniques and tools for assessing performance of systems, i.e. reliability, availability, or probability of messages missed in a network. Analytical or numerical solutions are only possible for very simple systems, so the simulation is the only alternative for systems of interest. Some existing communication systems and various operational criticism such as the handling of air traffic control system of the future European train (ETCS) or the operation of a nuclear power station, require very high reliability. A failure of the system should be a rare event in these models. In these cases there	4	O	2

	would need a time of enormous computing activity to actually assess by using an ordinary simulation process that fault probability. Therefore there will be approached a method of acceleration of rare event simulations so that it will be possible to study these critical cases through simulation. Description: Networks in tandem. Jackson networks. Reliability. Availability. Fault-tolerant systems. Simulation of discrete events. Components of a simulation model. Random numbers generation. Statistical analysis of results. The problem of infrequent events. Methods of acceleration of simulations. The RESTART method.			
Software Architectures and Metamodels	Objectives: The objective is to provide solid training for the student in the field of Software Architecture that will enable him/her to start research in some of the sub-areas of this discipline. Description: Introduction. Basic concepts. Architectural styles. Software for distributed systems architectures. Software connectors. Architecture description languages. The role of metamodeling in software architectures. Quality attribures of an architecture. Design decisions in software architectures.	6	O	1
Advanced Construction of Software Products	Objectives: To provide the students with fundamental, theoretical and practical knowledge necessary for the use of advanced application development techniques while preserving the traceability of the software. Description: Software Construction . Agile Software Development. Models and domain specific models. Model-driven Development (MDD) software. Software Product Lines (SPL). Emerging approaches to Software development.	6	O	2
Management of Data, Information and Services	Objectives: Provide the students with the fundamental knowledge and skills to understand and use emerging techniques in data information and knowledge management to be applied to innovation processes. Description: Structure and extraction of information in structured, semi-structured and unstructured data. Ontologies and semantic integration of data. Data information and knowledge management.	6	O	1

	Agile techniques in the evolution of information systems. Services and clouds.			
Intellectual Property and Software Intensive Systems	Objectives: Showing the student the rules on intellectual property so that it allows him/her to choose the appropriate license according to the particular intensive software system. Description: The concept of copyright. History and legal conceptions. The purpose of copyright: The work. The author and other right holders. Content of the copyright. Exceptions and limitations. Protection in the digital environment. Internet. Collective management of the author rights. Contracts for the exploitation of works. Licensing and innovation. Alternative models of contracts. International procurement of software. Crimes and other illicit. Sanctions. Study-case in the fight against piracy. The digital environment. International protection of copyright. The patentability of software. Advantages and disadvantages.	6	O	2
Geoinformatics & Context-Aware Computing	Objectives: The aim of the course is to show the possibilities of the incorporation of geo-referenced elements, information from the users' s environment and from the user himself/herself in order to develop new types of services demanded by our information society. As a supporting element of this type of technology there should be included mobile phones and smartphones, GPS systems, access to cartographic databases, GIS, interaction with geo-referenced information services, geo-referenced information mashups, etc. Description: Positioning with GPS. Access to databases with georeferenced information, built mashups, georeferenced information. Username profiles and recommending systems. Information agents for ubiquitous computing. Augmented reality. Context Aware Computing.	6	O	1
Mobility, Usability and Accessibility	Objectives: The objective of the course is to provide the participating students all the skills needed to analyze, assess and develop systems based on information and communication technology for the benefit of	6	0	1

	accessibility and communication in transport, focusing on the transmission of information through human-machine interfaces. It also aims to ensure the student's knowledge in cutting-edge areas in engineering and automatics systems oriented to environmental and contextual control, wireless sensor (XMesh ZIGBEE) networks and mesh networks. Finally, this course will provide the students with the necessary tools for the analysis and development of next generation security systems shipped in motor vehicles as well as the development of advanced systems for assisting driving. Description: User requirements for the development of their activities and social participation. What the users want and need for their full social interaction in communication and mobility. Ergonomics in user interfaces. Communication and transport accessibility: accessible interfaces including on-board interfaces. Criteria for accessibility for web publications. The WCAG 2.0. Design and audit of the interfaces from the point of view of accessibility and quality. Introduction to environment control systems. WSAN technology. Knowledge frontier. Development of theoretical-practical assignments about environment control. Introduction to security in car with special attention to persons with reduced mobility. Passive safety in cars by design. Active safety in automobiles. Intelligent transport systems. Sensors in transport. Sensory fusion techniques. Techniques for navigation and control of vehicles (autonomous vehicles). Study-cases.			
Neural Networks and their Applications	Objectives: To prepare the student for research in the field of the neural networks and their application in the construction of real systems. Description: Basic concepts of NN: biological aspects. Taxonomy of artificial NN. Supervised and non-supervised NN. Basics of artificial NN: propagation, activation and transfer functions, architectures, connections (types), training, processing .Non-supervised models (self-organizing maps, ART), supervised models (multilayer perception, RBF, …). Artificial NN applications.	6	O	2
Remote Sensing	Objectives: Introducing students to visual and digital processing techniques for images received by remote sensing space systems. Understanding the algorithms for analysis and interpretation. Learning current applications. Description:	6	O	2

	Concept and development of remote sensing. Physical principles of remote sensing. Space remote sensing systems. Image analysis techniques. Information extractio: non-supervised and supervised classifications.			
Master Thesis		15	M	2

Research Foundations in Computer Science and Information Technologies MANDATORY COURSES (M)
Advanced Research Seminars MANDATORY COURSES (M)
Computer Sciences MANDATORY AND OPTIONAL (M/O)
Innovation in Software Engineering OPTIONAL COURSES (O)
Intelligent Systems for Accessible Mobility and Communication OPTIONAL COURSES (O)