Master of Science
Advance Computer Architecture

Courses description

Fuzzy Logic-Based Intelligent Circuits

Fuzzy logic have impressive applications for intelligent systems. In this course, fundamental concepts and fuzzy logic based computational models and architectures are presented as follows:
1. Notions about Fuzzy Logic and applications which use fuzzy logic.
2. Description of RC architectures, a survey of RC (Reconfigurable Computing) application domains, and a classification of currently available RCs.
3. A typical RC design flow and the fundamental problems in the design automation of RCs.
4. An overview of the SPARCS synthesis and partitioning environment.
5. The computational models used to capture the design specification in SPARCS.
6. Techniques used to solve the temporal and spatial partitioning problems, respectively.
7. Techniques for solving the interconnection synthesis problem.
More, the course will provide insight into techniques used to solve some primary issues in design synthesis for RCs.

Numerical Methods in High Performance Computing

The Numerical Methods in High Performance Computing lecture studies state-of-the-art parallel computing architectures in the context of modern parallel programming paradigms. We show the motivations and trends of the latest HPC systems, and give an insight in the design and implementation of parallel computing systems. We give the basics of mathematical modeling and numerical methods and data structures employed in HPC from systems of differential equations, automatic differentiation, optimization problems, solving systems of nonlinear equations, to basic linear algebra packages, eigenvalues, eigenvectors, and chaotic systems. We study a number of scientific applications requiring HPC systems with examples from research and industry. We present tools and techniques for profiling and parallel debugging. We show how to

perform performance analysis, as well as serial and parallel code optimizations. We also present partitioning and load balancing techniques for parallel computing applications, and aspects of hybrid MPI/OpenMP programming. We conclude with a presentation of frameworks for automated code parallelization and generation on state-of-the-art computing architectures like homogenous and heterogeneous multicore systems and GPUs.

Wireless Sensor Networks

Wireless Sensor Networks are distributed systems that consist of a multitude of smart sensors which are spread in a given environment. These networks operate as pervasive computing systems which integrate and also challenge in many ways classical distributed systems and networking. Sensor nodes are usually tiny, low-power devices, equipped with sensings, computation and wireless communication capabilities. This course aims to ellaborate on a wide range of subjects, including embedded operating systems, wireless network protocols, power management, real-time and middleware services which can run on wireless sensor node hardware.
During this course, students will have the opportunity to learn the fundamental concepts of sensor node design, implement sensing systems using the protocols, algorithms and operating systems that are taught, program, simulate and design sensor node hardware and software and solve different design problems in teams or individually.

VLSI advanced systems

1. Reconfigurable computer systems. Introduction. Von Neumann Computer. New computing paradigms.
2. Reconfigurable devices- Introduction. Field Programmable Logic Arrays _FPGAs. FPGA's components. Blocks interconnection. Structural organization. FPGA based design flow.
3. Associative memories (Content Associative Memories – CAM). Associative processors. Algorithms. CAMs: principles, organization, technologies, architectures.
ASIC and FPGA CAM implementations. CAM applications: data compression, network switch, ATM switch, Memory mapping, Associative processors. A classic associative processor features. FPGA based classic associative processor. FPGA based special purpose associative processor. Generic associative processor. Associative algorithms implementation on programmable associative processors. Arithmetic algorithms, data

base algorithms, symbolic processing algorithms. Reconfigurable structures based associative algorithms implementation of: max, min, sort, sel.
4. FPGA attached coprocessors based speedup implementation of intensive computations algorithms. FPGA circuits speedup computation
5. Some high performance reconfigurable computing system implementations. Experimental platforms for reconfigurable FPGA based computing systems. Platform organization, PS/2 and VGA interfaces. Arithmetic processor: partitioned and non-partitioned execution and control units implementations. CORDIC algorithms FPGA implementations. CORDIC algorithms fundamentals. Trigonometric functions implementations. Iterative and non-iterative CORDIC processors. FPGA iterative CORDIC algorithm implementation. Some application specific oriented associative processors implementations. FPGA based reconfigurable computing systems implementations conclusions.

Advanced Microprocessor based Systems

Presentation and use of current technologies used by microprocessor technology and advanced processing techniques as well as advanced features of microprocessor systems. General description and function of advanced microprocessor systems architectures: vector architectures and advanced multimedia, streams architectures, multithreaded architectures, multicore and multiprocessor circuits, architectures polymorphic core grid based on clusters on FPGA or asynchronous. Presentation and use of advanced programming models and compilation. Presentation and use virtual machines in the development and execution of current microprocessor systems. Presentation and methods of dynamic compilation in systems with advanced microprocessors. General and function description of advanced fault tolerant architectures. Applying machine learning techniques ML ("Machine Learning") at the advanced microprocessor systems. Study, development and analysis in terms of hardware / software of the advanced microprocessors systems.

Real Time processing based on Microprocessors

Real-time systems design in terms of hardware and software. Hardware structures for air conditioning devices control, hardware structures for lighting control systems in a building; hardware structures for a complex data acquisition system. Software systems

for real time control of intelligent buildings using service oriented architectures. Analysis, creation of specifications, design and implementation of web services for hardware control. Analysis, creation of specifications, design and implementation of services for intelligent management of hardware devices in real time. Voice commands recognition systems used in real-time systems. Gesture recognition systems used in real-time systems.

Parallel and Distributed Systems

The course presents a new approach of parallel and distributed system, which consists of a collection of interconnected stand-alone heterogeneous systems cooperatively working together as a single, integrated computing resource. In the course are presented the type of clusters, cluster architecture, new concept in OS services for distributed processing , physical cluster interconnections and interconnect support, cluster programming environments, monitoring and performance analysis tools.
The course presents the essence of Grids how to utilize highly flexible network architectures, and how to sharing of all computing resources, not just data. Are presented the grid technologies, an extensible and open Grid architecture, general aspects of basic components that enable interoperability among different Grid resources. There are presentend the principal Grid characteristics: Wide geographical distribution, Heterogeneous, Resource sharing, Multiple admin policies, Resource coordination, Transparent access, Dependable, Consistent, Pervasive. It is presented a Sample Grid Computing Environment: Resource Sharing & Aggregation and Grid Architecture for Computational Economy. The Layered Grid Architecture is presented.
In the second part of the course the students have to choose a topic of application of the Grid computing and they have to present an essay about it.