University POLITEHNICA of Bucharest

Faculty of AUTOMATIC CONTROL and COMPUTERS

Master of Science
Service Oriented Architecture for Enterprise

Courses description

SCADA and PLC networks

The course aims to consolidate and transfer of extensive knowledge regarding the architecture, the development of software applications for real-time distributed control of discrete, repetitive processes, interconnection and integration of PLC networks in flexible production structures. Software - Hardware architectures for data acquisition and processing intelligence processes are analyzed, merging data from different sensors, identification and traceability of products, measurement of process parameters in a structured environment through SCADA solution. It shows discrete control functions of multivariable processes using the concept of Discrete Event Dynamic System. Distributed networks with interconnected PLC's are considered for movement control of material flow in production systems, against which it shows the communication techniques OPC server communication protocol is presented. Laboratory aims the setting of theoretical knowledge by examples on PLC and industrial controllers families regarding the design methods and implementation of SCADA solutions for complex, discrete, repetitive process control applications. Case studies and scenarios on real industrial applications using programming environments SCADA and DCS (Delta V CitectScada) are performed.

Wireless devices and networks for product-driven automation

Wireless networks can represent important subsystems of automatically controlled processes and systems. These networks are a combination of hardware devices and software applications, all needed for the quick and efficient interconnection of the components and/or services provided by the system. The objectives of this course are: to introduce wireless communication networks; to describe their embedding in control systems; to classify the networks based on their structure and their use cases; to analyze wireless local area networks; to present the typical hardware infrastructure for each class of networks; to present the protocols and the software applications used for different classes of wireless networks; to present solutions for the implementation and deployment of wireless networks.

Information systems security

The course discusses topics regarding the security of stand alone systems but also security of systems integrated in networks: security models, security in organizations, cryptography, public key infrastructure, physical infrastructure, infrastructure security, authentication and access, wired and wireless networks security, intrusion detection systems, security practices and attacks, messaging, web components, secure software development, disaster recovery, risk management, change management, privilege management, privacy, forensics, legal issues.
The discipline offer also hands on training on: Linux security, vulnerabilities and exploits, brute force and dictionary based attacks, software bombs, firewall configuration, ip address and port scanning, vulnerability scanners, Metasploit, security auditing, penetration testing.

Requirements management and business process modelling

This lecture presents a perspective on the role of architecture, requirements engineering and tool integration at the business level of an organization. Business modelling creates an abstraction of a complex business and establishes a common understanding that can be communicated to the business‘s stakeholders (e.g. owners, management, employees, and customers). Objectives: to provide students with basic knowledge on using models to understand the actual business and its goals, processes, resources, and rules; to provide students with basic knowledge on using models to understand how the business functions facilitates improvements to the business, and helps to identify new business opportunities; to help students understand how to use the business models to identify the correct requirements for the software that supports the business; to present guidelines on how to produce a business model and what it should contain; to present business patterns on how different aspects of a business can be modelled; to help students understand how the information and knowledge in a business model can be used to identify the proper requirements on software systems that support the business.

Data flow modelling and computing networks

The goal of this course is to develop for students the abilities of modeling, understanding and analyzing the information flows corresponding to an organization functioning and of integrating these information in the design and development of medical information systems. The formal tool used for modeling is represented by discrete Petri nets, the same tool being used for analysis (both the qualitative one and for the quantitative one). During

the course, the main features of modeling with Petri nets, the means of doing both types of analysis and also the information related to network topologies, products identifying and management devices and the features of data storage and retrieval in these networks.

Software applications design and implementation

This discipline presents the current trends in software applications design and implementation focusing not only on the functional requirements, but also other requirements categories, such as quality attributes. It presents software modelling concepts and notation of UML and its extensions, including SysML and MARTE, and their usage in representation of software applications designs. This course is structured in several chapters. In the beginning it discusses about software architecture issues and how to tackle the requirements complexity in the most important design decisions, by using architectural styles, patterns and tactics. It continues with detailed design based on object-oriented analysis and design, application domain-driven design and patterns and implementation issues. Also the course includes component-based applications design and software development with services. Finally, it ends with software evolution issues and building applications in the cloud.

Service oriented architectures and web technologies

Considering the actual impact of SOA (Service Oriented Architectures) principles, architectural style and related technologies in many different domains like information technology, business, e-government, healthcare and others, the main topics of the syllabus are: SOA origins – open system architectures; SOA evolution – heterogeneous distributed systems, middleware technologies; SOA concepts and trends – basic components of SOA, SOA management principles, adopting SOA related issues, problems and solutions; Web services versus SOA services; Web technologies currently used for SOA implementation; standardization activities related to open system architectures, interoperability of components and SOA.

Fundamentals of service science

Service Science is a new interdisciplinary field that studies the structure and behaviour of service systems. The SS course contains two parts: the first one is dedicated to a general presentation of the service system concept and the second one contains an introduction to some methodologies for service system development.

Firstly, the concept of service system is discussed within an ontological approach followed by the brief presentation of four important theoretical approaches: the service-dominant logic, the principles of Service Science, the Viable System Model (VSM), proposed by Stafford Beer within the theory of organizations, and finally, the Theory of Constraints (TOC) adapted to the service sector.
The part dedicated to service systems methodological tools contains a presentation of some of the classical constrained optimization approaches allowing decision making and a quantisation of the key performance indices of a service system: linear and nonlinear programming problems, with focus on the significance of basic theoretical concepts such as duality and the Lagrange multipliers as shadow prices, game theoretical approaches for interaction models, network models as a general framework also for allocation problems and, finally, dynamic optimization models based on the principle of optimality and the Bellmann equation, allowing off- and on-line optimal decision making, respectively.

Enterprise resource planning

The course introduces Enterprise Resource Planning (ERP) systems attempting to integrate several data sources and processes of an organization into a unified system.
The course discuss the following topics (each topic being introduced and concluded by a case study): enterprise systems for management, systems integration, enterprise systems architectures, development life cycle, implementation strategies, software and vendor selection, operational and post-implementation, program and project management, organizational change and business process reengineering, ethics and security management, supply chain management, customer relationship management. The discipline offers hands-on training on strategic Enterprise Management using specific modules of the OpenERP software platform, the exercises are based on the main modules of the application: introduction exercises, case study: company details, database and users setup, purchases, sales, pricelists, human resources management, accounting, project management, stock management, production management, document management system.

Business analytics and optimization for enterprise

During the course the students will learn how can use the information to enable enterprise transformation and creates sustainable differentiation through advanced information management and analytical services, deep industry and domain expertise, and world class solutions required to address complex business and societal opportunities across an entity's entire value chain. This training will help students to have solid information and

think beyond traditional capabilities with applied research and emerging technologies that will address the needs of a more instrumented, interconnected, and intelligent world.

Applied artificial intelligence through rapid deployment automation

The course propose the knowledge transfer in two fields of actuality for: enhancing production process quality, autonomy and adaptability of processes to changes in the production environment, automated visual inspection of products in fabrication flow, intelligent behavior to special events: Applied Artificial Intelligence (AAI) and Rapid Deployment Automation (RDA). The concepts and the methods of AI which can be applied in processing and conditioning (detection, recognition, localization, measuring, inspection) the material flow through complex image processing are also studied in rapport with modern production structures. The project for AAIRDA has the main goal to allow students to create complex automatic management applications for the material flow in production structures where batch planning, operation/product sequencing and resource/operation allocation are achieved through multi-agent systems with distributed intelligence.

Enterprise modelling and integration

The main objective of the course consists in presenting the methods and principles of modelling business processes and integrating these business processes in production enterprises (discrete and repetitive production). The modelling and integration of work and business processes is essential for assuring the enterprise is competitive and agile when changing client orders, when the dynamics of the market changes and also for dealing with the complexity of the relations between clients and customers. The course aims at describing and offering solutions for enterprise restructuring (administrative, technical and support processes) and integration of the new processes. Currently, there is a rising demand from production enterprises for viable and precise techniques for modelling and application of accumulated expertise and know-how. Enterprise modelling is perceived as a precondition for enterprise integration. Engineering, economical and management personnel from an enterprise should understand better the logic behind business operations, should understand how the methods and techniques for re-engineering, simplifying and outsourcing work and be able to consolidate the culture and the experience of the company, share data and knowledge and develop common application with associated enterprises.

IT services and project management

The course objective is to develop theories and integrated methods of project management and effective use of various informatic tools through: analyzing problems and making decisions; stages and processes of project management, techniques and tools used in project management; informatic services for assisting project management; risk analysis, case studies.
During the applications, informatic projects will be developed and the results will be evaluated; analysis of key performance factors, project planning, implementation and documentation of process analysis, project implementation, verification and validation of results.

Supply chains and logistics

"Supply Chain and Logistics" is a program of study concerned with the efficient and timely flow of materials, products, and information within and among organizations. A supply chain is a network of organizations that cooperate in order to optimize the flow of materials between the original supplier and the end user (client), resulting in a rapid and cost efficient flow of materials. Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, storing, conversion and all logistics management activities. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.

Multi-agent systems for enterprise control

The objective of the course is the description of distributed control architectures for discrete and repetitive production processes. The roadmap will follow the evolution of control from CIM systems (*Computer Integrated Manufacturing*) to the latest developments in the control field – MAS (*Multi-Agent Systems*) and HMES (*Holonic Manufacturing Execution Systems*). The structure of the classical control architectures will be presented: centralized, hierarchical, heterarchical and semi-heterarchical, with a

special focus on the last category. The multi-agent formalism is used to implement the distributed control of discrete and repetitive processes based on the Distributed Artificial Intelligence concept.
The course deals with the new formalisms for distributed control of production processes characterized by interconnected resources: supervisor control, product-driven automation, MAS for manufacturing and holonic control. In this framework there will be defined: the reference control architectures (PROSA, ADACOR, COBASA), the composing entities (holons) as both physical and informational entities used in production control and tracking, holon aggregation, the design stages of a holarchy, implementation and integration solutions of the informational production system (business (ERP) level with the process level).

Distributed database and knowledge base for production

In modern production systems, a great amount of information is stored in distributed databases, according to the production flow. At the same time, operators make a series of operational decisions without relying on the information acquired in the knowledge base. With regard to the distributed databases, this course discusses fragmentation techniques, fragment allocation in distributed systems, ACID properties, execution of distributed transactions and preservation of data integrity as well as data replication in distributed databases. Non-SQL databases are described in terms of main features, classifications, implementation models with examples using open source distributions: Hadoop, MongoDB, and Cassandra. Also, it approaches methods of knowledge acquisition, representation languages, and knowledge base build-up, including preservation of its consistency, inference mechanisms in binary and multivalent logic.

Development and defending the master thesis

The hours for this discipline will be used for the development and presentation of the master thesis: this module includes R&D activities carried out individually by the student for thesis development, as well as special training activity and tracking the student progress by its mentor. The mentors are the teachers teaching courses in the master program, they can collaborate with engineers from companies when master project is developed in a collaborative framework university - company. General objectives are to achieve the student's dissertation thesis through individual research, team collaboration and coordination; transfer of scientific and technical knowledge to develop master projects, identification, description and implementation of processes and project management services , R&D management for solution development, testing management,

experimentation in applied research, taking different roles in a research team, describing clear, concise, orally and in writing of the results obtained during the solving of a set of proposed issues, preparing students for the highest training cycle, cycle of doctoral training in the field of specialization "service systems".

Research

The research module is dedicated to develop research themes with high degree of complexity, mainly in connection with research projects of the teachers who teach at this master or projects in partnership with companies. Research topics will be chosen from: topics already proposed in third semester (first semester, second year) to be extended with new developed innovative, new research proposed by teachers of this master, the subjects proposed by the research university partner companies in various joint research programs and joint initiatives to promote innovation in the production of goods services, supply and delivery of goods. This subject gives the students the ability to analyze a problem, to conduct research with high complexity, to integrate in research teams, working in a team and to assume responsibilities in a project R&D. The research activity will be conducted under the supervision of the teacher who proposed the topic of research undertaken by the student and he will also provide documentation and materials. The reference material (articles, books) will be made available to students either electronically (online) or in printed form.