

Post-academic course

ICT Software & Data processing



Scientific Coordination

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Part I: The hardware-software interface

Module 1: Computer architecture

Module 2: Operating systems

Module 3: Virtualization

Part II: Software development

Module 1: Introduction to software development and programming

Module 2: Distributed computing basics

Module 3: Advanced distributed computing

Module 4: Software quality improvement

Part III: Databases

Module 1: Databases, data models and database models

Module 2: Conceptual database design

Module 3: Relational databases

Module 4: Object technology in databases

Module 5: Practical database management

Module 6: Advanced techniques



This program allows to
obtain a certificate
granted by the Ghent
University





introduction

ICT in Continuing Education: the IVPV success story

By the end of the previous century, the IVPV together with Agoria challenged the shortage in ICT-specialists by setting up a large scale IT course. For one or two evenings per week, around 2000 employees throughout Belgium and Europe faithfully attended the videoconferences organised by the Flemish universities. Many participants took exams on one or more modules, and received a university certificate. The course was a true milestone for industry, and gave a new élan to many ICT-experts. Today Agoria teaches us that again there is a growing shortage in ICT-specialists. The IVPV picks up the Agoria inquiry, and revitalises a new large scale ICT course. As always, the course is demand driven, and the content has been set up in close collaboration with industry.

The current ICT Software & Data Processing course is the second part of a large scale international ICT course organised by the Institute of Continuing Education at Ghent University. It is divided in four main sections: ICT Networking and Security (first semester 2008), ICT Software & Data Processing, ICT Multimedia and ICT & Business. All parts are scheduled within 2008-2009. If you want to be updated about the future parts, send an e-mail to ivpv@ugent.be.

The programme

The ICT Software & Data Processing course entails 3 parts which can be followed separately

Part I: The hardware-software interface

The first part discusses the hardware-software interface. The goal of this course is (i) to teach the basics about modern processors, (ii) to explain the role of the operating system, and (iii) to elaborate on the technical and operational aspects of virtualization. After taking this course, the student will be able to better understand the relation between the hardware and the performance of an application, and write software in such a way that it makes better use of the hardware resources (faster, consuming less energy, ...).

This course is aimed at people with some programming experience, but there is no hardware knowledge required.

Part II: Software development

The second part addresses software development. A first introductory module discusses the software development process and handles different programming implementation paradigms. In the second module, basic architectures and middleware

platforms are described for developing distributed applications. Web oriented development as well as enterprise application development is addressed. More advanced middleware technologies, including support for Service Oriented Architectures, is the main topic of module 3. The course concludes with a module on software quality improvement, presenting processes to guide the software quality improvement process.

The course is intended for people with some software background. Although some programming knowledge might be helpful to follow the course, programming skills are not a prerequisite.

Part III: Databases

In the third and final part of this course, databases are dealt with. It discusses the most important and topical principles of database systems, thereby striving for accuracy and completeness in width, rather than for completeness in technical depth. The objective of the databases course is twofold. On the one hand the course is meant to make participants familiar with the concepts and aspects that are connected to (working with) database technology. On the other hand, the course is also meant to provide a practical guide for designing, implementing, managing and manipulating databases. As a starting point, we have chosen for a general approach that is closely connected to practice, but does not focus on any specific commercial product.

This course is aimed at people with some technological background, although they need not to be experts in ICT. Some basic knowledge on data structures and basic programming skills are recommended, but not required.

Post-academic Course Certificate granted by the Ghent University

This programme is part of the Ghent University post-academic courses. A post-academic certificate granted by Ghent University can be obtained for each part individually. To receive a certificate for Part I, one should attend all modules and successfully take exams for these; For part II, one should attend at least modules 2, 3 and 4 and successfully take exams for these. For part III, one should attend all modules and successfully take exams for these.

Example questions, giving a precise idea of what can be asked at the exam, will be given in advance. Course certificates are a personal merit: participants who aspire a certificate cannot be replaced, others can.

programme

Part I: The hardware-software interface

Module 1: Computer architecture

Computer architecture is the discipline that studies and designs computing systems: processors, memory subsystems, interconnects, and input/output subsystems. The study of the basic principles of computing systems is an essential part of any computer training program: understanding the behaviour of the hardware is key to designing efficient software systems.

This module explains the basic concepts of modern computer systems: the important difference between architecture and organisation, how data is represented, how high-level programs are translated into machine instructions, the impact of the programming language and programming style on the performance of a program, how a modern processor executes machine instructions (pipelined, in-order, superscalar, out-of-order, multithreaded, multi-core, VLIW), the impact of the memory subsystem on the performance and on the power consumption of an application.

Teacher: Koen De Bosschere

Organisation: 4 plenary sessions theory

Reference book: David A. Patterson, John L. Hennessy, Computer Organisation and Design: The Hardware/Software Interface, 3rd edition, 621 pp, Elsevier Science and Technology Books, June 2007.

Module 2: Operating systems

An operating system is the primary interface between an application and the hardware. Most people are familiar with the end-user aspects of operating systems (desktop, file browsers, configuration panels, etc.), but very few are familiar with the internal organisation and operation of an operating system. Again, the formal study of operating systems helps software developers to write better software, and to make better use of the hardware resources of the computing system.

This module explains the basic concepts of operating systems: the difference between jobs/processes/threads/fibers, the interprocess communication and synchronization, the management of memory and disk space, the management of external devices (I/O), and the basics of protection.

Teacher: Koen De Bosschere

Organisation: 4 plenary sessions theory

Reference book: Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, 7th Edition, 944 pp, Wiley, John & Sons, 2005.

Module 3: Virtualization

Virtual Machine Monitors (VMM) or Hypervisors can be considered as “the next generation” operating systems. This kind of virtualization technology allows running multiple operating systems or execution environments on the same physical platform.

The possibilities of virtualization technology are enormous: server consolidation, fast provisioning, isolated sandboxes... However, the challenges of running many different guest OS + applications combinations on one physical platform should not be underestimated. In this course, we will try to understand the trade-offs that the software and hardware engineers encounter when designing a VMM and hardware virtualization technology. This will allow us to understand what the bottlenecks are, what the best practices are and what is (not) possible with the current

and near future virtualization technologies. A good understanding of the basics of operating systems (module 2) is critical.

Teacher: Johan De Gelas

Organisation: 2 plenary sessions

Part II: Software Development

Module 1: Introduction to software development and programming

Basic software engineering terminology and practices are introduced, in order to understand how modern processes are able to meet high quality demands for developed software. The software life cycle is looked at, and most important UML models are presented for each phase. A second important topic concerns the translation of these models into an executable format. A taxonomy of programming paradigms and languages is given. Given its importance in practice, a lot of emphasis is put onto the object oriented model, addressing the today's most relevant OO languages (Java, C++ and C#). This module is not intended as a programming course, but rather introduces basic software and programming concepts as fundamentals for the subsequent course modules.

Teachers: Bart Dhoedt, Filip De Turck.

Organisation: 2 plenary sessions theory + 1 lab exercise

Module 2: Distributed computing: basic concepts

Starting from a basic software understanding, this module extends towards applications running on different computers in parallel. The object paradigm is extended towards distributed object models, and remote method invocation is studied in more detail. The module then focuses on two important architectures for client-server applications: web based development and architectures suitable for enterprise applications. After introducing the major challenges for both environments, main .NET and Java technologies are discussed. In particular, the Java Enterprise Edition (JEE) is discussed, as well as frameworks building on JEE (such as Apache Struts).

Teachers: Bruno Volckaert, Bart Dhoedt.

Organisation: 3 plenary sessions theory + 1 lab exercise

Module 3: Distributed computing – advanced technologies

Building on the fundamentals of developing client server applications introduced in module 2, this module extends towards more advanced technologies for building state-of-the-art distributed systems. Advanced middleware services, geared towards the telecommunications industry are presented, and important software technologies are studied (including CORBA, Jain-SLEE and Parlay). A second topic addresses massively parallel computing. After presenting software mechanisms for safe resource sharing and synchronisation between parallel tasks, middleware services for cluster and grid computing are investigated in more detail. A final topic in this module addresses Service Oriented Architectures (SOA). Here, mainly web service oriented technologies are introduced to allow construction of complex software systems based on atomic, loosely coupled services.

Teachers: Filip De Turck, Bruno Volckaert

Organisation: 3 plenary sessions theory

programme

Module 4: Software quality improvement

In this module we look at software development in a business context requiring a continuous improvement in terms of quality, delivered functionality, schedule and cost. We first present a business case to show how performance improvements can be introduced in a software development organisation based on established quality principles. The module continues with an overview of the Capability Maturity Model Integration (CMMI), a formal framework for evaluating the performance of a software organisation and for guiding its continuous improvement. Lessons learned and recommendations for efficient and effective application of the model are given as a conclusion of this module.

Teacher: Jozef De Man

Organisation: 1 plenary session theory

Part III: Databases

Module 1: Databases, data models and database models

This module deals with the basic concepts of databases, data models and database models. Insight in the terminology, history and the most important components of database systems and developments of database technology is an absolute prerequisite when developing, manipulating, managing and studying databases. In this module, we give a brief overview of database models that are important in practice. Special attention is given to aspects that are important in view of application development.

Teacher: Guy De Tré

Organisation: 1 plenary session theory

Module 2: Conceptual database design

One of the most important steps in the implementation of a new database is database design. The design process consists of three main phases. In the first phase, an abstract, conceptual schema is designed. The development of the database schema is the second design phase (logical database design). In the third design phase the database schema is implemented in a database management system (physical database design). This module is dedicated to the conceptual database design. For this use, a technique called extended entity relationship modelling (EER-modelling) is applied. An advantage of EER-modelling is that the resulting conceptual schema is independent of any database model. Due to this independency, the conceptual schema can be translated to the logical database schema that is best suited.

Teacher: Tom Matthé

Organisation: 1 plenary session theory + 1 group session lab exercises

Module 3: Relational databases

Relational database systems are nowadays most frequently used for database implementation and are part of the ICT-infrastructure of most companies. To efficiently work with a relational database system, understanding the underlying relational database model is necessary. In this module, we describe the most important structural, behavioral and integrity aspects of the relational database model. Another topic dealt with in this module is logical relational database design. Not only does it supply the necessary skills to design new relational databases, it also provides

the necessary insights to diagnose existing databases and to identify and to solve potential design problems. Next, the SQL language for relational databases is studied. Query processing is clarified by explaining how query statements are translated to mathematical expressions in relational algebra, how these expressions are processed by the database management system and how the results are constructed and returned to the users. We also study some aspects of query optimization.

Teachers: Guy De Tré, Tom Matthé and Niels Charlier

Organisation: 2 plenary sessions theory + 2 group session lab exercises

Module 4: Object technology in databases

In this module we present the essence of (using) object technology in databases. We provide a solid basis for a more in depth study of this topic, and also teach you to analyze environments where object technology has been used, so you can recognize potential application fields and develop object oriented data(base) management solutions. Both the ODMG a priori standard for object oriented databases and the new SQL3 standard for object relational databases are studied.

Teacher: Guy De Tré

Organisation: 1 plenary session theory

Module 5: Practical database management

This module consists of four parts. As soon as databases are constructed, users and applications can use them. In the previous modules the focus was on user interaction via query languages like SQL. An alternative approach is to build applications that interact directly with the database. In the first part of this module we study different database access techniques for applications. The second part of the module handles security. Different security techniques are studied and discussed to prevent unauthorized access. On the other hand, the third part discusses facilities to protect databases against crashes and to recover from crashes. The last part of the module deals with facilities to share databases among concurrent users. In order to fine tune a database management system, it is important to understand the 'concurrency' control mechanism, which is required to prevent disadvantageous interferences.

Teachers: Guy De Tré and Niels Charlier

Organisation: 3 plenary sessions theory

Module 6: Advanced techniques

In the first part of this module we explain the essence of working with data warehouses. Large data collections often contain very valuable information that could not be revealed with regular querying techniques. Advanced analysis techniques are required to mine this 'hidden' information (data mining techniques). In the second part of this module we study some basic data mining algorithms. The last part of this module discusses how telecommunication technology can be used to remotely access database systems and to set up 'distributed' databases where parts of a database are fragmented and/or replicated over different database servers and approached as one single logical database. We give an overview of what distributed database technology offers nowadays and identify some technological challenges for the near future.

Teachers: Guy De Tré and Axel Hallez

Organisation: 3 plenary sessions theory

Scientific Coordination

Part I: The hardware-software interface

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Department of Electronics, parallel information systems group, Ghent University



Part II: Software Development

Prof. dr. ir. Bart Dhoedt

Department of Information technology, Ghent University



Part III: Databases

Prof. dr. Guy De Tré

Department of Telecommunications and information processing, Ghent University



Teachers

- > **Niels Charlier**
Department of Telecommunications and information processing, UGent
- > **Koen De Bosschere**
Department of Electronics and information systems, UGent
- > **Johan De Gelas**
Departement PIH Kortrijk, Hogeschool West-Vlaanderen,
- > **Bart Dhoedt**
Department of Information technology, UGent
- > **Jozef De Man**
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- > **Guy De Tré**
Department of Telecommunications and information processing, UGent
- > **Filip De Turck**
Department of Information technology, UGent
- > **Axel Hallez**
Department of Telecommunications and information processing, UGent
- > **Tom Matthé**
Department of Telecommunications and information processing, UGent
- > **Bruno Volckaert**
Department of Information technology, UGent

Subscription form

Subscribe preferably via www.ivpv.ugent.be OR by using this form:

Part I: The hardware-software interface

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|--|--------|
| <input type="checkbox"/> Module 1: Computer architecture | 600 € |
| <input type="checkbox"/> Module 2: Operating systems | 600 € |
| <input type="checkbox"/> Module 3: Virtualization | 300 € |
| <input type="checkbox"/> Part I: all modules | 1200 € |

Part II: Software development

| | |
|---|--------|
| <input type="checkbox"/> Module 1: Introduction | 450 € |
| <input type="checkbox"/> Module 2: Distributed computing basics | 600 € |
| <input type="checkbox"/> Module 3: Advanced distributed computing | 450 € |
| <input type="checkbox"/> Module 4: Software quality improvement | 150 € |
| <input type="checkbox"/> Part II: all modules | 1350 € |

Part III: Databases

| | |
|---|--------|
| <input type="checkbox"/> Module 1: Databases, data models and database models | 150 € |
| <input type="checkbox"/> Module 2: Conceptual database design | 300 € |
| <input type="checkbox"/> Module 3: Relational databases | 600 € |
| <input type="checkbox"/> Module 4: Object technology in databases | 150 € |
| <input type="checkbox"/> Module 5: Practical database management | 450 € |
| <input type="checkbox"/> Module 6: Advanced techniques | 450 € |
| <input type="checkbox"/> Part III: all modules | 1700 € |
| <input type="checkbox"/> All Parts | 4000 € |

Reference Books

- Part I, Module 1: David A. Patterson, John L. Hennessy, Computer Organisation and Design: The Hardware/Software Interface, 3rd edition, 621 pp, Elsevier Science and Technology Books, June 2007. (€50,50 VAT incl.).
- Part I, Module 2: Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, 7th Edition, 944 pp, Wiley, John & Sons, 2005. (€100 VAT incl.).

Return completed and signed form (use capitals):

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practical info

Practical Information

The programme consists of different modules. Each module can be followed separately. Plenary sessions (theory) are organised as follows: 18h00-19h30: session 1, 19h30-20h00: sandwich break, 20h00-21h30: session 2

Location

Plenary sessions (theory): Ghent University, Institute for Continuing Education, classroom A, Campus Engineering Faculty, Building 'Magnet' (nr. 904), Technologiepark, 9052 Zwijnaarde, Belgium. Follow A2 and then IVPV Classroom A.

Lab sessions: Ghent University, PC-Room E & F, Plateaustraat 22, B-9000 Gent, Belgium

Group Reduction

When a participant of a company subscribes for the equivalent of the complete course, a reduction of 20% is given to all additional subscriptions from the same company, even on single modules. Invoicing is then done by one company invoice. For larger numbers of subscriptions, additional reductions could be envisaged: please contact the IVPV-secretariat. The group reduction does not apply for streaming fees.

Scheduling & Participation Fee

The participation fee includes the tuition fee, course notes, soft drinks, coffee and sandwiches. Payment occurs after reception of the invoice. All invoices are due in thirty days. All fees are exempt of VAT. Transfer and conversion costs are at the expense of the participant. Reference books are billed directly by the bookshop. Special fees apply for UGent employees and members of Ghent University Association (Consult the website from within the Ghent University/ Association network).

Language

English is used in all presentations, lab exercises and documentation, so a good knowledge of this language is necessary.

Streaming Video

All lessons can be watched on-line via streaming video. For more information, please contact us.

Training Cheques ('Opleidingscheques – BEA')

Ghent University has been recognised as an official training supplier within the framework of the training cheques of the Flemish Community. Thereby you can save on the participation fee of this training (www.vlaanderen.be/opleidingscheques). For employers we refer to www.BEAweb.be (authorisation ID: DV.0103 194)

Cancellation Policy

Cancellation should be done in writing (either letter or fax). Cancellation can be done on individual modules or on full subscriptions. When cancelling up to 10 days before the start of the course/module, an administrative fee of 25% on the requested payback is due. When cancelling less than 10 days before the start of the module, the full fee is due.

Information & Documentation

More detailed information about the course in general or on particular modules can be found on our website: <http://www.ivpv.ugent.be>. The IVPV secretariat can also be contacted:

Instituut voor Permanente Vorming

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E-mail: ivpv@UGent.be

| Part I: The hardware-software interface | Theory | Lab* | Fee** |
|--|--|--------------------|--------|
| Module 1: Computer architecture | 16/09/08, 18/09/08, 23/09/08, 25/09/08 | | 600 € |
| Module 2: Operating systems | 30/09/08, 02/10/08, 07/10/08, 09/10/08 | | 600 € |
| Module 3: Virtualization | 14/10/08, 16/10/08 | | 300 € |
| Exams | 08/11/08 or 12/11/08 | | |
| Part II: Software development | Theory | Lab* | Fee** |
| Module 1: Introduction | 29/01/09, 05/02/09 | 10/03/09 | 450 € |
| Module 2: Distributed computing basics | 12/02/09, 19/02/09, 05/03/09 | 17/03/09 | 600 € |
| Module 3: Advanced distributed computing | 12/03/09, 19/03/09, 26/03/09 | | 450 € |
| Module 4: Software quality improvement | 02/04/09 | | 150 € |
| Exams | 25/04/09 or 28/04/09 | | |
| Part III: Databases | Theory | Lab* | Fee** |
| Module 1: Databases, data models and database models | 30/04/09 | | 150 € |
| Module 2: Conceptual database design | 07/05/09 | 26/05/09 | 300 € |
| Module 3: Relational databases | 14/05/09, 19/05/09 | 02/06/09, 09/06/09 | 600 € |
| Module 4: Object technology in databases | 28/05/09 | | 150 € |
| Module 5: Practical database management | 04/06/09, 11/06/09, 16/06/09 | | 450 € |
| Module 6: Advanced techniques | 18/06/09, 23/06/09, 25/06/09 | | 450 € |
| Exams | 05/09/09 or 08/09/09 | | |
| Part I: all modules | | | 1200 € |
| Part II: all modules | | | 1350 € |
| Part III: all modules | | | 1700 € |
| All Parts | | | 4000 € |

* Extra lab sessions will be organised if necessary.

** Exempt of VAT.

This schedule may be subject to modification.