



IMSE Course Catalogue

International Master in Service Engineering

August 2011



Dear (prospective) IMSE student,

In this IMSE Course Catalogue, you will find a complete overview of all courses currently offered in the International Master in Service Engineering, a joint Master's programme, delivered by University of Stuttgart, University of Crete and Tilburg University.

For each course, core course or elective course, you will find information on the course content, the learning objectives, the literature involved and the examination methods.

Please remember that this course catalogue was issued in August 2011, and that the courses offered in the years to come may be subject to minor changes.

We hope to welcome you as an IMSE student in the future.

Kind regards,

The IMSE Academic Committee

Professor Willem-Jan van den Heuvel (Tilburg University)
Professor Bernhard Mitschang (University of Stuttgart)
Professor Frank Leymann (University of Stuttgart)
Professor Christos Nikolaou (University of Crete)

Core Courses

Course US01: Workflow Management (6 ECTS)

Overview

- Evolution of Workflow Technology
- Business Reengineering (BPM Lifecycle, Tools,...)
- Languages and Notations (BPMN, FDL, BPEL, XLANG, WSFL)
- Process Model Graphs (Mathematical Syntax and operational Semantics)
- Transaction Support in Workflows
- Architecture of WFMS (Navigator, Executor, Worklist Manager,...)
- Advanced Features (Subprocesses, Model- and Instance Modifications)
- Different Modeling Foci (Document Routing, Control-/Data-Flow, Case Handling)

Learning Objectives

At the end of the lecture the students understood the fundamental elements of languages for specifying workflow/process models. The concept of a workflow-based application (or process aware information system, respectively) and corresponding lifecycle is clear. The architecture of workflow environments is understood. The formal syntax and operational semantics underlying many workflow languages has been comprehended. Especially the languages BPEL and BPMN can be used to create own models. Advanced mechanisms like fault- and exception handling in workflows are clear.

Examination

An oral examination will take place at the end of the lecture. Participation in the exercise sessions is mandatory. Each student must have presented in at least one exercise session and must have received at least 50% of the credits achievable in the exercises.

Literature

1. Leymann, Roller. Production Workflow. Prentice Hall 2000.
2. Reader

Course US02: Web Services (6 ECTS)

Overview

- Application Server (JEE)
- Messaging and Loose Coupling
- The Web as a Middleware Platform
- Web Protocols (HTTP, SMTP)
- Dominant Architectural Styles (REST, SOA)
- QoS at the Message Level (SOAP, WS-TX/BA)
- Service Descriptions (WSDL, Policy)
- Service Discovery (UDDI, MEX)
- Virtualization (Service Bus, Grid)
- Service Composition (Orchestration, Coordination, Choreography)

Learning Objectives

At the end of the lecture the students understood the technologies and basic mechanisms behind service-based applications both, from a requester and a provider perspective. The fundamental architectural styles in this area (REST and SOA) are clear and can be related to standards like HTTP, SOAP, WSDL etc.. Virtualization and loose coupling as basic concepts of a SOA have been comprehended. The architecture and basic features of the Service Bus are understood.

Examination

An oral examination will take place at the end of the lecture. Participation in the exercise sessions is mandatory. Each student must have presented in at least one exercise session and must have received at least 50% of the credits achievable in the exercises.

Literature

Alonso, Casati, Kuno, Machiraju. Web Services. Springer 2004.

Papazoglou. Web Services. Prentice Hall 2008.

Weerawarana, Curbera, Leymann, Storey, Ferguson. Web Services Platform Architecture. Prentice Hall 2005.

Course US03: Message-Based Applications (6 ECTS)

Overview

- The Integration Problem
- RPC and Tight Coupling
- MOM Architecture and Interfaces (MQ, JMS)
- Categories of Integration Pattern
- Endpoints
- Messages
- Channels
- Routing
- Transformations
- Management
- Messaging and Web Services

Learning Objectives

After attending the lecture, students understand the problem of application integration as origin for Web Service technology, and the generic principle for solving this problem, which is based on the use of Message-Oriented Middleware. The architecture of MOM is clear, as well as details about the MQI and JMS. The relevant patterns used to solve the integration problem are mastered.

Examination

An oral examination will take place at the end of the lecture. Participation in the exercise sessions is mandatory. Each student must have presented in at least one exercise session and must have received at least 50% of the credits achievable in the exercises.

Literature

Hapner, et al. Java Messaging Service API Tutorial and Reference Addison-Wesley 2002

Hohpe, Woolf. Enterprise Integration Patterns. Addison-Wesley 2004

Course US04: Datawarehousing and Analytics (6 ECTS)

Overview

- Introduction to Data Warehousing
- Data Warehouse Architecture
- Data Warehouse Design
- Extraction, Transformation, Load
- ETL as a Services
- Introduction to Analytics and Analytic Services
- Real-Time Reporting
- Online Analytic Processing as a Service
- Data Mining as a Service

Learning Objectives

After attending the lecture, students understand the challenges behind the integration of heterogeneous data sources in consolidated data warehouses and the provisioning of analytical services. They know the typical data warehouse architecture as well as current trends, e.g., real-time data warehousing. Further topics are the structure of a data warehouse and the main processes for building data warehouse s(extraction, transformation, load). A special focus is on technologies to analyze data warehouse data, e.g. reporting, online analytic processing and data mining, and their role as part of analytic services.

Examination

An oral examination will take place at the end of the lecture. Participation in the exercise sessions is mandatory. Each student must have presented in at least one exercise session and must have received at least 50% of the credits achievable in the exercises.

Literature

William H. Inmon: Building the Data Warehouse, Wiley; 2005

Other literature will be provided mostly via Web-published papers.

Course US05: Service Management and Clouds

Overview

- Principles of Service Management
- Virtualization
- Data Center Economics
- Cloud Management Platforms
- Operational Support Services
- Business Support Services
- Layers of Cloud Services
- Infrastructure Services
- Software Platform Services
- Application Services
- Public and Private Clouds
- Cloud Federation and Integration
- Security and Clouds
- Application Patterns for Clouds

Learning Objectives

Through the lecture and course work, student will gain an understanding of the data center economics and the technical and business drivers for cloud computing, They will understand foundational technologies as well as what drives affinity of work loads for cloud computing. They will also be able to assess the choices of delivery models an IT organization faces.

The lecture will draw both on implementation experience as well as recent research insight.

Examination

An oral examination will take place at the end of the lecture. Participation in 80% of the lectures is mandatory.

Literature

1. Reader with technical reports and scientific papers

Optional Courses (Year 1, Semester 1)
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Will be decided on an as-needed basis.

Core Courses

Course CU01: Digital Economics (6 ECTS)

Overview

Economics and Industrial Organization topics:

- supply and demand, utility and welfare functions,
- markets and game theoretic formulations of competition problems, Pareto optimality and the Nash equilibrium,
- Systems of agents for managing resources, introduction to the theory of firms, the economics of network industries.
- Information goods
- Transaction cost economics
- Service pricing, costing, metering and billing
- Theory of Constraints
- Link formation models, critical link monotonicity
- Auction models: Single/Multi-unit auctions
- Network and evolution economics

Learning Objectives

The goal of the course is the introduction of the new economy emphasizing the socio-economic principles that apply in emerging business models including networked enterprises and e-marketplaces.

Examination

Written, homework, student presentations

Literature

S. Goyal, "Connections: An Introduction to the Economics of Networks (Paperback)", Princeton University Press, 2009.

Oz Shy, The Economics of network Industries, Cambridge University Press, 200.

[Hal R. Varian](#), [Joseph Farrell](#), [Carl Shapiro](#), "The Economics of Information Technology: An Introduction (Raffaele Mattioli Lectures)" (Paperback), Cambridge University Press, 2004.

Reader with contemporary scientific articles

Course CU02: Introduction to Service Networks Science and Engineering (6 ECTS)

Overview

- What is a Business service?
- Business Service Eco-systems
- How does one discover quickly and reliably the service he needs among thousands of other being offered?
- How does one match or adapt her requirements to the specifications of offered services?
- How does one compose simple services, dynamically, into other more complex ones, for which there is demand?
- How does one translate business models, plans and objectives of a single business or of a group of businesses, into service providers' networks that satisfy these objectives?
- How does one discover out of existing interaction patterns in communities and markets, new innovative and sustainable service networks?
- How does one generate trust to services offered, how is security ensured and compliance to sometimes contradictory national legal frameworks about businesses?
- Aggregation and disaggregation in business segments – the role of ICT in formalizing and outsourcing business functions such as: payroll, e-procurement, F&A, CRM, HR, service centers and help desks. ERP systems. Formalizing and modelling business objectives, key performance indicators (KPIs). Introduction into competitive strategies.

The above are some of the topics and open problems that are studied in this course, primarily through the research literature and simulation tools wherever this is feasible.

Learning Objectives

This course is an introduction to the methods, models, theories, practices and technologies that affect the transformation of businesses via the use of Information and Communication Technologies (ICT) in general, and SOA more in particular.

We live in an era where services are the primary economic activity in all developed and developing countries, followed by the industrial and the agricultural economic activities. Moreover, the development of ICT, of the broadband networks, and of cloud computing facilitate, at least theoretically, the use of millions of electronic and human services throughout the planet.

Examination

Presentations, papers (50%), and term project (50%)

Literature

Hefley, Bill; Murphy, Wendy, Service Science, Management and Engineering, Springer 2008.

Reader with contemporary scientific articles.

Course CU03: Process Management Systems (6 ECTS)

Overview:

- Business Processes(basic concepts, modeling)
- Design, analysis, and verification methods
- Workflow Systems organisation and architecture
- Synchronization, control, communication and monitoring of process enactment
- Workflow Analysis
- Workflow Patterns
- Workflow development tools and software
- Service-Oriented Computing
- Web/e-Services (specification, discovery, composition)
- Applications

Learning objectives:

The course deals with the workflow technology which represents the basic framework for the development of large scale business management systems. Starting from abstract descriptions of business processes the course will examine modeling, design, analysis, development and verification methods of the processes. Afterwards the course will study the management of implemented business processes using the workflow systems technology. The organisation and architecture of workflow management systems will be examined under the emergence of recent trends in the research fields of e/web-services and web-based information systems. The course will also examine the service infrastructure and functionality required by modern process management systems.

Examination: assignments and paper presentations

Recommended reading: lecture notes, collection of research papers

Course CU04: Infrastructure Technologies for Large Scale Service-Oriented Systems (6 ECTS)

Overview:

The course focuses on large scale service-oriented systems and their architectures (Web services, service-oriented architectures, REST/SOAP, Web 2.0, mashups, etc.), design principles for scalable high performance, management of SLAs (infrastructural service-level agreements) and information lifecycle, configuration and change management databases and ITIL processes, design optimization to meet application requirements, the role of the human factor, and case studies (Amazon, Google, Yahoo).

Learning objectives :

The explosive development of e-services in recent years has created the need for the design, implementation, deployment and management of infrastructures to support large scale service-based systems. The course objective is the introduction to e-service infrastructure technologies that can support scalable systems designed to support services. In the course we will examine existing design techniques and current research problems present while designing these systems as well as their possible solutions.

Syllabus

1. Review of Web services, service-oriented architecture and implementation techniques.
2. Review of distributed and parallel system principles.
3. Service-level agreement systems.
4. Cloud services, *{infrastructure, platform, software}-as-a-Service*) and IT outsourcing.
5. Application-specific service systems such as e-store service systems (Amazon), e-mail services such as Google, Yahoo, etc., search engines, etc.
6. Management of services with federated configuration and change management databases (CCMDB)
7. Human Resources management for large scale e-service systems
8. Information/data/storage lifecycle management
9. Systems for high availability, and data protection (backup, replication, versioning, etc.).
10. Design and deployment of low cost scalable services.

Literature:

Alonso, Casati, Kuno, Machiraju: Web Services: Concepts, Architectures, and Applications, Springer Verlag.

Sape Mullender (Ed.), Distributed Systems, ACM Press, New York, NY.

Smith, Nair: Virtual Machines: Versatile Platforms for Systems and Processes, Morgan Kaufmann Series in Computer Architecture and Design.

Articles from ACM, USENIX, IEEE and personal notes

Examination: homework assignments, quizzes, term project.

Optional Courses (Year 1, Semester 2)

Course CUOp1: Multicore Architecture Programming (6 ECTS)

Overview:

- The landscape of multi-core/many-core computing
- Roofline models of performance
- Programming using threads
- OpenMP
- Cilk
- Intel TBB
- Programming models for multi-cores with explicitly managed memories
- CUDA
- OpenCL
- MapReduce

Learning objectives:

The course explores models and languages for programming multi-core systems as well as the compiler and runtime support needed for running software written with these models/languages efficiently. Having completed this course the student acquires skills on parallel programming and performance engineering on state-of-the-art multi-core and many-core processors, with homogeneous or heterogeneous architecture. The student acquires these skills through studying research papers and programming parallel applications originating from a variety of scientific domains and disciplines (HPC, embedded systems, computational biology, massive data processing and data mining, audio-video processing, among others)

Literature:

The course uses reading material based on papers and lectures on parallel programming patterns, models, and languages for multi-core computer architectures. Though no textbook is formally adopted for the course, students interested on a focused training on parallel programming for emerging hardware may use the following textbooks:

Lin and Snyder, [Principles of Parallel Programming](#), Addison-Wesley, 2009, ISBN-10:0321487907, ISBN-13:9780321487902.

Mattson, Sanders and Massingill, [Patterns for Parallel Programming](#), 2005, Addison-Wesley, ISBN-10: 0321228111, ISBN-13: 9780321228116.

Kirk and Hwu, [Programming Massively Parallel Processors](#), 2010, Morgan Kaufmann, ISBN-13: 978-0-12-381472-2

Examination: Presentation of research papers by students and research project

Course CU Op2: Distributed Systems (6 ECTS)

Overview of topics:

- Introduction
- System Models
- Communication
- Processes
- Naming
- Basic Asynchronous Network Algorithms
- Shared Memory versus Networks:
- Logical Time
- The Consensus problem – Fault tolerance
- Global Snapshots and Stable Properties
- Network Resource Allocation
- Transactions and Concurrency Control
- Consistency and Replication
- P2P Systems

Learning objectives

Most modern systems and applications are distributed for a variety of reasons, including resource sharing, fault-tolerance, performance, etc. Distributed algorithms have arisen in a wide spectrum of applications, including telecommunications, distributed information processing, scientific computing, real time process control, etc. Global information systems, telephone networks, banking applications, reservation systems, weather prediction, aircraft and nuclear power plant control, sensor networks, and many others, employ distributed computations and depend critically on the use of distributed algorithms, which should therefore be correct and efficient.

This course aims at providing students with a deep understanding of distributed systems. In particular it studies the principles, techniques, and practices relevant to the design and implementation of such systems.

The major objectives of the course are summarized as follows:

- Understanding the principles underlying the functioning of distributed systems;
- Realizing the challenges encountered during the design and analysis of a distributed system;
- Identifying efficient methods for facing these challenges and designing efficient distributed algorithms and systems;
- Learning how to design, implement and evaluate correct distributed algorithms;
- Identifying the desired properties that should govern the design of distributed

systems;

- Understanding how to design well-structured such distributed systems that exhibit the desirable properties;
- Being able to identify features and design decisions that may cause problems, as well as others that cannot be realized by any correct distributed system implementation.

Literature

George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed systems: Concepts and Designs", Addison-Wesley, fourth edition, 2005.

Andrew Tanenbaum and Maarten van Steen, "Distributed Systems, Principles and Paradigms".

N. Lynch, *Distributed Algorithms*, Morgan Kaufmann, 1996

H. Attiya & J. Welch, *Distributed Computing: Fundamentals, Simulations and Advanced Topics*, Morgan Kaufmann, 1998

E. Simon, "Distributed Information Systems", Mc Graw Hill, 1996

S. Mullender , "Distributed Systems", Second Edition, Addison-Wesley, ACM Press Frontier Series, 1993

A. Goscinski, "Distributed Operating Systems, The Logical Design", Addison-Wesley, 1991.

M.T. Ozsü, P. Valduriez, "Principles of Distributed Database Systems", Prentice Hall, 1991.

Examination:

Paper presentation: 25%

Project: 35%

Final Exam: 40%

Course CU Op3: Mobile Networks and Computing (6 ECTS)

Overview:

- Fundamentals on radio propagation
- Wireless physical layer
- Wireless technology (bluetooth, 802.11, CDPD)
- Routing protocols on wireless networks
- Wireless data dissemination systems
- Sensor networks
- Location-sensing systems
- Security issues on wireless networks
- Statistics (probabilities, CDFs, percentiles, confidence intervals, stochastic order, QQ plots)
- Tools for monitoring wireless networks
- Performing measurement studies on wireless networks

Learning objectives:

The seminar introduces fundamental concepts on networks, wireless technology, and mobile computing and discuss the main research challenges and topics of mobile computing. Topics include radio propagation, wireless physical layer, IEEE802.11, performance analysis of wireless networks, wireless information access and dissemination systems, mobile peer-to-peer systems, routing protocols for mobile networks, location-sensing systems, and sensor networks. Students read and present research papers, experiment with new technology (e.g., handheld devices, access points, wireless networks) and investigate novel ideas and applications in the area via semester-long projects.

Literature:

[802.11 Wireless Networks, The definitive guide](#). Matthew S. Gast, O'Reilly, 2002, ISBN 0-596-00183-5.

[Wireless Communications Principles and Practice](#) Theodore S. Rappaport, Prentice Hall (Second Edition), ISBN 0-13-042232-0.

[Computer Networking: A Top-Down Approach Featuring the Internet](#), James Kurose, Keith Ross, Addison Wesley.

ISBN10: 0321227352

ISBN13: 9780321227355

Examination:

Final grade determined by grade of presentation, paper reviews, assignments, quiz, and class participation.

Course CU Op4: Cybersecurity Lab (6 ECTS)

Overview

Theoretical foundations in, cryptographic algorithms, cryptographic protocols, access control models, formal methods, security policy, etc. provide the necessary background for students to understand the complexity and importance of computer and network security. However this theoretical background is not sufficient by itself for students to understand the real world implications of cryptography and network security.

The lab is designed to give students the chance for a hands-on experience on the theoretical knowledge they have accumulated by taking other security-oriented class. This hands-on experience can be very important in the job market. It will accomplish its goals by a number of in-lab programming exercises.

Broadly the topics that will be covered are: Basic cryptographic algorithms and protocols, authentication and authorization protocols, and access control models. Common network (wired and wireless) attacks as well as typical protection approaches, including firewalls and intrusion detection systems. Operating systems and application vulnerabilities and exploits, along with countermeasures.

Learning objectives:

Hands-on experience on host and network security

Literature:

M. Bishop, Computer Security – Art and Science

B. Schneier, Applied Cryptography

W. Stallings, Cryptography and Network Security - Principles and Practice

W. R. Cheswick, S. M. Bellovin, A. I. Rubin, Firewalls and Internet Security

Examination: Lab exercises

Course CU Op5: Greek for Beginners (6 ECTS)

Overview

Greek for Beginners introduces main structural features of Modern Greek and examines Case (Nominative - Accusative of Nouns and Adjectives), Tense (Present, Simple Past and Future) and Subjunctive, based on elementary communicative acts and settings (greeting, speaking on the phone, asking about prices, etc.).

Examination

Written/Oral

Literature

Reader: Basic Greek for International Students

Courses S-Cube / TSL (Year 1, Summer-School)

Co-organized by the Transformation Services Laboratory (TSL) of the Computer Science Dept. of the University of Crete, the Institute of Computer Science of the Foundation for Research and Technology - Hellas (ICS-FORTH) and the EU-funded network of Excellence S-Cube.

Course SC01: The Services and Software Architectures Infrastructure & Engineering Summer School (SSAIE) (3 ECTS)

Overview

The SSAIE Summer School brings together the best international experts on software and services and graduate students, young researchers and professionals from leading academic, research and industrial organizations across Europe and around the world.

In addition to high quality training, the Summer School helps forge a new research and scientific community on Service Science Management and Engineering (SSME). The Summer School fosters the free exchange of ideas and helps the participants to network and start new cooperative research projects.

The Summer School is organized by the Training and Summer School Collaboration Working Group CWG), that brings together projects of the IST SSAIE unit (http://cordis.europa.eu/fp7/ict/ssai/home_en.html). The IMSE students will be able to participate to the Summer School, that typically lasts from one to two weeks. The students will be able to interact with their fellow participants and also present their Master's thesis to them.

This Summer School is a continuation of a series of workshops on Service Science and Engineering, the first of which was held in Crete, in May 2007. The topic of this first workshop was: "The Business Process in the Service Science" ([see here](#)). The second workshop was held in Palermo, Italy from June 2nd to June 6th. It was by invitation only and limited to 40 participants ([see here](#)). The topic was "Perspectives on Services". The third will take place this year from June 16-19, again in Crete, Greece.

Learning Objectives

Get in touch and understand what the leading European research and industrial organizations are doing in Service Science and Engineering research.

Examination

Reports on the summer school sessions, Master's thesis defense.

Literature

Notes and presentations given by the summer school lecturers.

Course TU01: Service Oriented Architectures (6 ECTS)

Overview

- Service Oriented Architectures and Web Services;
- Web Services Description;
- Web Services Discovery;
- Event-based Processing;
- Web Service Analysis;
- Web Service Design;
- UMM, UML for Services;
- SOA Patterns.

Learning Objectives

The Internet-based economy is gearing towards the real world of fully automated business processes. Automated services have emerged as the next generation of Web based technology for exchanging information over the Internet and promise to revolutionise the process of developing and deploying distributed software applications. Service Oriented Architecture is a logical way of analyzing and designing a software system to provide services to either end-user applications or to other services distributed in the Internet, via published and discoverable interfaces.

The objective of this course is to present the principles and fundamental underpinnings of Web Services and Service Oriented Architectures, concentrating on service analysis and design. The course will be a blend of theory and practical lab sessions.

Examination: written exam

Literature

Papazoglou Michael. Web Services: Principles and Technology, Prentice Hall; 1st Edition, September 2007

Michael Bell, Service-Oriented Modeling (SOA): Service Analysis, Design, and Architecture, Wiley, 2008.

Course TU02: IT Governance (6 ECTS)

Overview

- Enterprise governance and IT governance
- Service-centric governance
- Governance models: COBIT, ITIL, SOA Governance Reference Model
- Compliance and Service Governance:
 - Sarbanes-Oxley
 - Tabaksblat
 - Clinger-cohen act
- Business process alignment

Learning Objectives

Modern enterprise turns to Service Oriented Architectures to achieve their desired business processes and objectives. With the needs to address governance, risk and compliance requirements in listed companies, more organizations acknowledge the importance of having effective IT-governance to harmonize the decisions about the management and control of IT to deliver significant values.

This course provides aims at learning its participants IT and SOA governance frameworks and models for provisioning control practices, ensuring continuous alignment between business processes and support infrastructure. The course will combine traditional lectures with case studies and group presentations.

Examination: written exam

Literature

Peter Weill and Jeanne Ross, "IT Governance", Harvard Press, 2005.
Eric Marc, SOA Governance, Wiley, September 2008

Course TU03: Business Process Integration (6 ECTS)

Overview

- Business Models;
- Business Relationships and Processes;
- Business Technology Infrastructure;
- Supply Chains;
- Business Modelling;
- E-Business Integration.

Learning Objectives

This course focuses on integrating business processes that flow within and between enterprises. The course addresses how enterprises collaborate, what coordination mechanisms, and technology are necessary to achieve collaboration and how these factors are reflected on the business processes of an enterprise.

The course contains an in-depth and integrated coverage of both business and technical issues including definitions, principles and strategy.

The objective of this course is to focus on how enterprises transform their structure and processes in order to collaborate with each other by integrating their business processes. The course will be a blend of theory and practical lab sessions.

Examination: written exam

Literature

Michael P. Papazoglou and Pieter M.A. Ribbers, e-Business Organizational and Technical Foundations, John Wiley & Sons, Ltd, 2006. ISBN 13: 978-0-470-84376-5 or ISBN 10: 0-470-84376-4

Course TU04: Enterprise Architecture (6 ECTS)

Overview

Knowledge objectives:

The new competitive agenda, driven by competition based on quality, speed and cost, and catalyzed by the enabling possibilities of new information technologies, forms the basis for new business models. Business models encompass the architecture of a form: the internal characteristics of the business venture, the external relations with business partners and the way IT and information assets are used. New business models require an integrative view on the business venture. In line with this the objective of the course is to study and explore the design and evaluation of enterprise architectures (EAs). Students should finish this course with a clear understanding of architectural choices and their consequences. Architecting is defined as the deliberate design of the enterprise as a whole. An EA comprises strategy, the internal and external organization, Information Technology and other management systems. Architecture decisions encompass questions like which competencies should be developed in-house and which outsourced, what is the appropriate organizational design, what should be centralized, or decentralized, what needs to be standardized, what type of longer term and short term relationships have to be developed with external business partners and suppliers. To build an effective foundation for their activities, companies must develop three disciplines (see Weill and Ross):

- The operating model (the necessary level of business process integration and standardization for delivering goods and devices);
- The enterprise architecture (the organization logic for business processes and IT infrastructure);
- The IT engagement model (the system of governance mechanisms to ensure alignment).

Managing at the enterprise level requires defining these disciplines, in terms of management requirements like Performance, Flexibility, Integration and Consistency. A clear architecture is a precondition for Business - IT alignment.

Skills objectives:

The predominant approach for this course is "Learning by example", i.e. demonstrating trends, developments, and discussing their strategic impact on businesses through in depth analysis of case studies. However, by extrapolating examples, students are prompted to "think through" and develop their own analytical and creative skills.

Examination: written exam

Literature

1. Ross, J.W., Weill, P. & D.C. Robertson, *Enterprise Architecture as Strategy*, Harvard Business School Press, 2006, ISBN 1591398398.
2. Reader.

Optional Courses

TU Op01: Business Process Management

Overview

BPM (Business Process Management) considers processes to be strategic assets of an organization that must be understood, managed, and improved to deliver value added products and services to clients. What is often overlooked is that these processes are based ultimately on communicative interactions between human actors, some of which are supported by IT. In this course, a radical communication research approach is pursued. In which the organization emerges out of communication practices. Students will learn how organization (both as entity as a process) and communication are closely intertwined, become aware of the many levels of communicative action. They also learn how to do organizational communication research.

The course has roughly three parts. In the first part, we discuss the concept and history of BPM and the relationship with communication and information. The second, central part follows the book of Taylor and Van Every. Attention will be paid to the work of Karl Weick, Erving Goffman, Fernando Flores, John Searle and many others. The theoretical concepts will be illustrated by case studies that at the same time show how to perform organizational communication research. The third part contains some capita selecta, for example, whistleblowing and leaks.

In the tutorials, the theory is being applied to various concrete IS topics, such as Process Design, Requirements Engineering, Knowledge Management and Innovation, based on research articles.

Literature:

J. R. Taylor & E. J. Van Every, *The Situated Organization*, Routledge, 2011, ISBN 9780415881685.

TU Op02: Management of Knowledge and Innovation

Overview

This course aims at understanding the successful Management of Innovation from a knowledge management perspective. It focuses on the knowledge, structures, processes and management competences that enable innovation in different technological and market environments. The innovation processes include a series of different activities, all of which entail the creation, sharing and application of knowledge, i.e. based not only on internal capabilities and competencies, but also on external sources of know-how. Thus, the course also focuses on Knowledge Management to systematically reflect on and capture knowledge derived from these different sources and innovation experiences (whether day-to-day improvements, incremental innovations, structured reviews or post-project audits).

The integrating themes will be the identification and development of core competencies, the constraints imposed by different technologies and markets, the structures and processes for organizational learning and innovation. The course draws on research and practices in a number of areas (i.e. strategy, marketing, organizational behaviour, networks, ICT, and knowledge management) to understand and exploit innovation and knowledge management at the operational and strategic levels. Topics include:

- Innovation: what it is and why it matters, theories of innovation, disruptive technologies;
- Innovation as a core business process, effective innovation management abilities and routines;
- The innovative organization: organizational structure, high involvement, team working, creative climate;
- Innovation strategy, appropriating the benefits from innovation, technology trajectories and competencies;
- Sources of innovation (knowledge push, needs pull, users as innovators,...) and tools to enable innovation search;
- Innovation networks: clusters, consortia, learning networks, open innovation,...;
- The innovation case: business plan, forecasting, adoption of innovations, risk, resources;
- New product development, commercializing technological products and complex products, service innovation;
- Ventures: Internal corporate venturing, joint venture and alliances, spin-outs and new ventures;
- Capturing the benefits of innovation; Exploiting knowledge and intellectual property;
- Managing knowledge, organizational knowledge processes;
- Knowledge management architecture and technologies;

Literature:

1. Tidd, J. & J. Bessant, *Managing Innovation: Integrating technological, market and organizational change*, John Wiley & Sons Ltd., 2009, ISBN 978-0-470-99810-6. 4th edition
2. Additional materials (articles) will be distributed in class or made available through Blackboard..

TU Op03: Workflow Management

Overview

The course treats the subject workflow management, i.e. the enactment of human work processes. The goal of the course is to teach how to model, analyze and improve human workflows with the techniques offered by a workflow management system.

Workflow management systems are standard information systems that manage the work distribution to between the members of an organization. Rather than ad-hoc solutions like email, workflow management systems are based on a clear understanding what a workflow is and how it can be enacted in a correct and resource-efficient way. In particular, we will discuss:

- The standard architecture of a workflow management system;
- Workflow modeling, i.e. representing workflows in way that their enactment can be computer-supported;
- Notations for workflow models;
- Petri net theory as basis for understanding the principles of workflows and their enactment: soundness, free-choice, well-handledness;
- Resource allocation for workflows;
- Workflow patterns, i.e. standard patterns for solving recurrent problems;
- Introduction to waiting queue theory;
- The simulation of workflow models;
- Matching real inter-arrival times by distribution functions;
- Measuring process performance indicators via data warehouses.

The course uses the WOPED system for practical exercises in workflow modeling. WOPED is available free of charge for educational purposes. The simulation of workflow is performed by the ARENA tool, which is available on practicum PCs. The practical exercises are performed in groups and have the character of a medium-sized project.

The course is designed for master students with information management background and for master students with interest in that field. The focus of the course is on the analysis of human work processes in enterprises, not on computer programming.

Literature:

Aalst, W. van der, *Workflow Management - Models, Methods, and Systems*, MIT Press, Paperback Edition 2004, ISBN 02-262-72046-9.

IMSE Thesis (30 ECTS) (Year 2, Semester 2)

The graduation phase (phase IV) is a mandatory part of the study. This phase encompasses two components: conducting the graduation project and the master's thesis.

Principally, IMSE allows two types of graduation projects: research internships and industry internships. Research internships are performed at one of the partner universities, and are aligned with ongoing research projects. Industry internships take place in an external organization and study how a practical problem in the area of service engineering, can be solved in an academic way. Note that placements for industry internships are facilitated by IMSE's industry associate members; if needed, additional external placement options may be pursued.

In either case, thesis work is identical at all three partner universities (30 ECTS); the main supervisor is from the university where the research is conducted, or –in other cases- allocated by IMSE's project management board. In addition, at least one co-supervisor from a partner university is added to the graduate committee assigned to each project. In case of industry internships also a industry supervisor is assigned; while (s)he will be responsible for your daily supervision, determining the final grade will be up to the discretion of (co-) supervisors from the academic partners.

Graduation projects may be conducted inside or outside the EU. Non-EU EM scholarship will fulfil the IMSE thesis within EU. EM regulations maximize the learning period in Third countries to 15 ECTS.

The availability of placements outside EU allows EU students to develop an international perspective on service engineering, while non-EU students may deepen their knowledge and cultural experience in this domain. In particular, European students enrolled in IMSE are offered the possibility to perform their research in China in the Technology Park, or, at CITRIS (UC Berkeley, USA). Note that the number of placements in the Technology Park and CITRIS is limited, and will be determined on a yearly basis. During and after the graduation project, you will write your research dissertation. At the end of the project, you present the key findings of your graduation project and defend your thesis during the S-Cube SSME Summer School.

The dissertation must address an open research problem in the area of service engineering, with a specialization in one of the course modules:

1. Service Middleware Architectures and Service Composition;
2. Service Analysis and Design;
3. Service network (value) analysis and optimization.

Subject and research plan are defined by the candidate in close collaboration – and in agreement with - with the supervisor. The thesis structure should follow a standard thesis-template.