



# DPT TELECOMMUNICATIONS SERVICES ET USAGES TELECOMMUNICATIONS, SERVICES & USAGES

INSA Campus LyonTech - 6 Avenue des Arts  
Batiment Claude Chappe  
69621 VILLEURBANNE CEDEX  
Phone : 0472436060

## Informatique

### Data bases and data mining - Part 1: Data Bases

#### IDENTIFICATION

CODE : IST-4-DBM1  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small project (with 4 hours of  
assistance) on computers  
- 2 hours of presentation of the project  
by the students

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. PETIT Jean-Marc  
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#### AIMS

This course introduces the most important concepts concerning the design and the use of databases. It covers the main issues in data modeling when considering the relational data model (structure, languages like relational algebra and relational calculus) and the key features of attribute-oriented models with respect to constructor-oriented models (like, for instance, Extended Entity-Relationship models). The fundamental concepts like the constraints and the normal forms will be explained and their impact on the quality of designed databases will be discussed. Finally, practical aspects of relational database design and use will be discussed. It includes a presentation of the SQL query language but also a short introduction to data warehousing and On Line Analytical Processing queries (OLAP). To be concrete, the students will have to understand the design of a real relational database and to practice database querying with a professional DataBase Management System (DBMS).

#### CONTENT

Introduction to data models and application to databases  
Studying the relational data model  
Structure  
Languages  
Constraints  
Introducing database design  
Using the Extended Entity-Relationship Model  
Normals forms and data dependencies  
Practical issues  
Using SQL  
Introducing Data Warehousing

#### BIBLIOGRAPHY

Heikki Mannila and Kari-Jouko Raiha. The Design of Relational Databases, 2nd Edition, 1994, Addison-Wesley.  
Serge Abiteboul, Rick Hull, Victor Vianu, Foundations of databases, 685 pages, 1995, Addison-Wesley  
Carlo Batani, Stefano Ceri, Shamkant B. Navathe. Conceptual Database Design: An Entity-Relationship Approach. 455 pages. Benjamin/Cummings.

#### PRE-REQUISITE

Set theory, basic notions in discrete mathematics and algorithms.

Last modification date : July 20, 2012

## Informatique

### Data bases and data mining - Part 2: Data Mining

#### IDENTIFICATION

CODE : IST-4-DBM2  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small project (with 4 hours of  
assistance) on computers  
- 2 hours of presentation of the project  
by the students

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. BOULICAUT Jean-Francois  
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#### AIMS

This course introduces data mining as an extension of standard database querying approaches. We motivate the need for new querying mechanisms to support data analysis and Knowledge Discovery from Databases (KDD) by means of data mining techniques. The classical data mining algorithms (clustering, classification, association rule mining) are introduced. We explain why it is interesting to study and implement such algorithms within the recent setting of constraint-based data mining. Finally, the design of data mining query languages is considered. To be concrete, the students will have to perform some practical data analysis tasks by means of the open source KNIME data mining tool. Beside the introduction of the most popular techniques, we will do our best to sketch research challenges in the area, including a discussion on the research results collected in Lyon during the last decade.

#### CONTENT

From data to knowledge: A database perspective to KDD  
Introducing the most important data mining methods  
Exploratory Data Analysis  
Clustering  
Pattern discovery  
Supervised classification  
Designing data mining query languages

#### BIBLIOGRAPHY

- [1] David Hand, Heikki Mannila, Padhraic Smyth. Principles of Data Mining. MIT Press, 2001, 546 pages. Chinese translation, China Machine Press, ISBN 7-111-11577-5, 2003.
- [2] Pang-Ning Tan, Michael Steinbach, Vipin Kumar. Introduction to Data Mining. Addison-Wesley, 2006, 710 pages.
- [3] Mohammed J. Zaki, Wagner Meira Jr., Fundamentals of Data Mining Algorithms, Cambridge Press. In Press (2011).

#### PRE-REQUISITE

Basic database notions, SQL

Last modification date : July 24, 2013



# DPT TELECOMMUNICATIONS SERVICES ET USAGES TELECOMMUNICATIONS, SERVICES & USAGES

INSA Campus LyonTech - 6 Avenue des Arts  
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Phone : 0472436060

## Informatique

### Java Programming

#### IDENTIFICATION

CODE : IST-4-JAV  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small exercices between sessions
- Final 1h exam

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. FRENOT Stephane  
stephane.frenot@insa-lyon.fr

#### AIMS

The aim of the course is to learn java programming. After a brief 2h general introduction, the work is done directly on computers. The course is structured in lectures that span the Java programming language and the virtual machine. The course is illustrated by practical sessions.

#### Skills

- Programming skills - Understanding Object philosophy as a design tool
- Rapid integration of on-line documentation
- Debugging skills

#### CONTENT

- General presentation of Java and object oriented language
- Object and Classes
- Virtual Machine and running java applications
- Methods and class structure
- Exceptions and Classpath
- Inheritance and Interfaces
- Data Structures with java
- Input/Output
- Multi-threaded applications
- Graphical User-Interfaces
- Applets

#### BIBLIOGRAPHY

- [1] Exploring Java 2nd edition, P. Niemeyer et J. Peck, Addison Wesley, 1997  
[2] Effective Java, Guy L., Jr. Steele, Joshua Bloch, et Josh Bloch, Addison-Wesley, 2003

#### PRE-REQUISITE

Algorithmic principles : assignments, loops, conditions, recursion.  
Programming basics in another language.

Last modification date : February 13, 2014



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## Informatique

### Middleware design and implementation

#### IDENTIFICATION

CODE : IST-4-MID  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

Projects

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. PONGE Julien  
julien.ponge@insa-lyon.fr

#### AIMS

This course focuses on the design and implementation of common middleware families as found in real-world distributed application architectures. We tackle the challenges addressed by middleware design through both the prism of classical distributed systems problems as well as the techniques used to simplify programming models.

Students will acquire useful knowledge in the age of cloud computing as a target of choice for building innovative products. Indeed, they will understand key elements in the design of popular frameworks, and they will learn about the common pitfalls of distributed systems.

#### CONTENT

- \* Introduction
- \* Concurrent programming
- \* Lock-free concurrent programming
- \* Aspect-oriented programming
- \* Component container design and usage
- \* Comparing distributed events with logical and vector clocks
- \* Consensus algorithms

#### BIBLIOGRAPHY

- [1] Andrew S Tanenbaum, "Distributed Operating Systems", Prentice-Hall
- [2] Sape Mullender, "Distributed Systems", Addison-Wesley
- [3] Clemens Szyperski with Dominik Gruntz and Stephan Murer, "Component-Software Beyond Object-Oriented Programming"
- [4] Richard Monson-Haefel, "Enterprise JavaBeans", O'Reilly
- [5] Gregor Hoppe, Bobby Woolf, "Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions", Addison-Wesley

#### PRE-REQUISITE

Java, networks, operating systems

Last modification date : February 12, 2014



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## Télécommunications

### Microwave Systems for Telecommunications - Part 1: Transmission lines

#### IDENTIFICATION

CODE : IST-4-MST1  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small project (with 4 hours of  
assistance) on computers  
- 2 hours of presentation of the project  
by the students

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. HUTU Florin Doru  
florin-doru.hutu@insa-lyon.fr

#### AIMS

Knowledge about high frequency systems. Choice of right transmission line considering applications. Matching circuit design. RF simulation tools. Basic principles of transmission lines. Comprehensive study of high frequency propagation and standing waves. Knowledge about matching circuits and applications. Different kinds of transmission lines. Link with the wireless propagation domain.

#### CONTENT

- Telegraphist Equations
- Reflection Coefficient
- Standing Waves
- Impedance Matching
- Smith Chart
- S parameters

#### BIBLIOGRAPHY

- [1] Brian C. Wadell, Transmission Line Design Handbook (Artech House), 1991  
[2] Philip C. Magnusson, Andreas Weisshaar, Vijai K. Tripathi, Gerald C. Alexander, Transmission Lines and Wave Propagation, Fourth Edition, CRC Press, 2000

#### PRE-REQUISITE

Good basis in mathematics

Last modification date : July 24, 2013



## Télécommunications

### Microwave Systems for Telecommunications - Part 1: Antennas and Propagation

#### AIMS

This course focuses on wireless transmissions basics. Starting from results from Maxwell's equations, the principles of radiated fields are exposed. Common characteristics of antennas are detailed, and the main families of antenna structures (wired, patch, horn, reflectors, arrays...) are exposed considering possible applications. The purpose is also to be able to establish a budget link of a radio transmission and to open on more advanced techniques which can enhance wireless systems' performance.

IDENTIFICATION	
CODE :	IST-4-MST2
ECTS :	3.0
HOURS	
Lectures :	0.0 h
Seminars :	20.0 h
Laboratory :	0.0 h
Project :	0.0 h
Teacher-student contact :	20.0 h
Personal work :	20.0 h
Total :	40.0 h

#### ASSESSMENT METHOD

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. VILLEMAUD Guillaume  
guillaume.villemaud@insa-lyon.fr

#### CONTENT

- Transmission chain
- Radio channel
- Elementary doublet
- Reciprocity, image theory, theorem of Babinet
- Antenna parameters: input impedance, bandwidth, directivity and gain
- Radiation pattern
- Budget link
- Wired antennas
- Slot antennas
- Patch antennas
- Horns
- Reflectors
- Antenna arrays

#### BIBLIOGRAPHY

- [1] J.M. Laheurte, Compact Antennas for Wireless Communications and Terminals: Theory and Design, Wiley, 2011
- [2] J.D. Kraus, Antennas, Mc Graw Hill, 2001
- [3] C. A. Balanis, Antenna Theory: Analysis and Design, 3rd Edition, Wiley

#### PRE-REQUISITE

Basis of electromagnetism and transmission lines.

Last modification date : July 24, 2013

## Réseaux & Services

### Network (Part 1)

#### IDENTIFICATION

CODE : IST-4-NET1  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small project (with 4 hours of assistance) on computers  
- 2 hours of presentation of the project by the students

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. VALOIS Fabrice  
fabrice.valois@insa-lyon.fr

#### AIMS

The main objective of this course is to understand the basic mechanisms of IP networks, both over Ethernet and 802.11 networks. After a general introduction to networking principles, we will introduce the classical OSI Network Stack as a comprehensive understanding to networking protocols and architectures.

Medium Access Control protocols will be considered for wired and wireless environment: Ethernet (802.3) and Wi-Fi (802.11) will be discussed in depth. We will focus the main part of this course on TCP/IP (Data Link and IP - Communication over IP - Transport layer UDP/TCP - IP addressing and basic routing - Advanced Networking, Filters and VPN - C networking programming).

#### CONTENT

- Introduction to networking
- Fundamentals of local networking (IEEE 802.11, 802.3)
- Data Link and IP networks
- Addressing and routing
- Transport protocols (TCP, UDP)
- Introduction to networking programming

#### BIBLIOGRAPHY

- [1] TCP/IP Illustrated, Volume 1: The Protocols, W. R. Stevens, Addison Wesley
- [2] TCP/IP Illustrated, Volume 2: The Implementation, W. R. Stevens, Addison Wesley
- [3] The IEEE 802.11 Handbook: A Designer's Companion, B. O'hara, A. Petrick, Institute of Electric & Electronic Engineers.
- [4] Computer Networking: A Top-Down Approach: International Version, J. F. Kurose, K. W. Ross, Pearson Education.
- [4] Ad Hoc Mobile Wireless Networks: Protocols & Systems, C. K. Toh, Prentice Hall.
- [5] VANET: vehicular applications and inter-networking technologies, H. Hartenstein, K. Laberteaux, Wiley.

#### PRE-REQUISITE

Basic networking. Wireless networks are not pre-requisite but are recommended.

Last modification date : July 20, 2012



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## Réseaux & Services

### Networks - Part 2

#### IDENTIFICATION

CODE : IST-4-NET2  
ECTS : 3.0

#### HOURS

Lectures :	0.0 h
Seminars :	20.0 h
Laboratory :	0.0 h
Project :	0.0 h
Teacher-student contact :	20.0 h
Personal work :	20.0 h
Total :	40.0 h

#### ASSESSMENT METHOD

Oral presentation of key scientific paper.

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. STANICA Razvan  
razvan.stanica@insa-lyon.fr

#### AIMS

This course is focused on emerging wireless architectures. After discussing the fundamentals of wireless communication and of the WiFi MAC/PHY-layer standard, we will introduce the spontaneous wireless networking paradigm and its advantages and challenges. We will then focus on the problem of routing in such distributed mobile networks, and discuss practical scenarios, including sensor networks, mesh networks and vehicular networks. Architectures, protocols and services/applications will be discussed.

#### CONTENT

- Fundamentals of Wireless local networking (IEEE 802.11)
- Wireless mobile ad hoc networks (MANETs)
- Routing in MANETs (DSDV, DSR, AODV, OLSR)
- Wireless sensor networks (IEEE 802.15.4, Wavenis)
- Vehicular ad hoc networks (IEEE 802.11p, IEEE 160.9x)

#### BIBLIOGRAPHY

- [1] Mobile Radio Networks, Networking & Protocols, B.H. Walke, Wiley.
- [2] The IEEE 802.11 Handbook: A Designer's Companion, B. O'hara, A. Petrick, Institute of Electric & Electronic Engineers.
- [3] Handbook of Sensor Networks: Algorithms and Architectures, I. Stojmenovic, Wiley.
- [4] Ad Hoc Mobile Wireless Networks: Protocols & Systems, C. K. Toh, Prentice Hall.
- [5] VANET: vehicular applications and inter-networking technologies, H. Hartenstein, K. Laberteaux, Wiley.

#### PRE-REQUISITE

Basic networking. Wireless networks are not pre-requisite but are recommended.  
See Networks & Part I.

Last modification date : September 24, 2013





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INSA Campus LyonTech - 6 Avenue des Arts  
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69621 VILLEURBANNE CEDEX  
Phone : 0472436060

## Informatique

### Operating Systems

#### IDENTIFICATION

CODE : IST-4-OPS  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Programming project (C/Linux). Computers are provided, but there is no dedicated lab session in the schedule.
- Short MCQ quizzes during each lecture.
- Written exam (1h).

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. MOREL Lionel  
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#### AIMS

The aim of the course is to present the fundamental concepts and issues in the topic of operating Systems. We will first take a short historical tour of computer systems and discuss why operating systems were introduced. We will then describe the major components and abstractions of a general-purpose OS. Finally, we will address the programming interfaces of many operating systems based on processes, various interprocess communication techniques and scheduling of processes.

#### CONTENT

- 1- Processes and threads: context switching and preemption, kernel thread models, address-space isolation
- 2- CPU scheduling: CPU-bound vs I/O bound processes, basic scheduling algorithms (FIFO, RR, SJF, SRTF)
- 3- Synchronization and Deadlocks: Shared memory vs message passing, race conditions, critical sections, semaphores and locks
- 4- Main Memory Management: allocation policies (best-fit, first-fit, worst-fit) free-list management, segmentation, swapping
- 5- Paging: page tables, Translation Lookaside Buffer, demand paging
- 6- Virtual Memory: average memory access time, page replacement policies (FIFO, OPT, LRU, NRU)

#### BIBLIOGRAPHY

- [1] Operating System Concepts Essentials, A. Silberschatz P. Galvin and G. Gagne, Wiley.
- [2] The C Language. Brian W. Kernighan, Dennis M. Ritchie.
- [3] Computer Organization and Design. David Patterson, John L. Hennessy.

#### PRE-REQUISITE

- Computer architecture: registers vs ALU, CPU vs bus vs memory, the Von Neumann cycle, address space vs memory size, hexadecimal notation and powers of two.
- Computer programming: control flow and variables, functions, loops, simple data structures such as arrays and linked lists.
- C language: write, run and debug simple programs on linux. design data structures including pointer fields, strings.

Last modification date : February 18, 2014



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## Projects

### Research Project

#### AIMS

The research project will be conducted within one of the three research laboratories (CITI, CREATIS, LIRIS). Partners of the IST semester, these laboratories develop high level research in the fields covered by the IST semester. The students will work within a research team alone or by two. They will have to make a bibliographic study, to develop their own contributions that will be presented in a final report and during an oral presentation.

#### IDENTIFICATION

CODE : IST-4-REP  
ECTS : 10.0

#### HOURS

Lectures : 0.0 h  
Seminars : 10.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 10.0 h  
Personal work : 150.0 h  
Total : 160.0 h

#### ASSESSMENT METHOD

#### TEACHING AIDS

#### CONTENT

#### TEACHING LANGUAGE

English

#### CONTACT

M. PONGE Julien  
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#### BIBLIOGRAPHY

#### PRE-REQUISITE

Last modification date : October 2, 2012



# DPT TELECOMMUNICATIONS SERVICES ET USAGES TELECOMMUNICATIONS, SERVICES & USAGES

INSA Campus LyonTech - 6 Avenue des Arts  
Batiment Claude Chappe  
69621 VILLEURBANNE CEDEX  
Phone : 0472436060

## Télécommunications

### Signal and Image Processing - Part 1: Signal Processing

#### IDENTIFICATION

CODE : IST-4-SIP1  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

- Small project (with 4 hours of assistance) on computers
- 2 hours of presentation of the project by the students

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. FRIBOULET Denis  
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#### AIMS

The course introduces the fundamentals of signal processing. Signals and systems are studied both in time and frequency domains. Fourier, Laplace and Z transforms are presented. Linear and Time Invariant Systems are analyzed through their impulse and frequency responses and their transfer function.

#### Skills:

To model, analyze and characterize a system in time and frequency.

#### CONTENT

- General signal and system properties
- Linear Time Invariant Systems and convolution
- Fourier Series, Fourier Transform: in continuous time and in discrete time
- Time and frequency characterization of signals and systems
- Laplace transform, Z transform
- Sampling

#### BIBLIOGRAPHY

- [1] Alan V. Oppenheim, Ronald T. Schafer, Ronald W. Schafer, Wayne T. Padgett , Discrete-Time Signal Processing, Prentice Hall, ISBN 0131988425, 1108 p., 2009.  
[2] Bernard Mulgrew, Peter M. Grant, John Thompson, John Thompson, Digital Signal Processing: concepts and applications, Palgrave Macmillan, ISBN 0333963563, 380 page, 2003.

#### PRE-REQUISITE

Good basis in mathematics

Last modification date : December 3, 2012



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## Télécommunications

### Signal and Image Processing - Part 2: Image Processing

#### IDENTIFICATION

CODE : IST-4-SIP2  
ECTS : 3.0

#### HOURS

Lectures : 0.0 h  
Seminars : 20.0 h  
Laboratory : 0.0 h  
Project : 0.0 h  
Teacher-student  
contact : 20.0 h  
Personal work : 20.0 h  
Total : 40.0 h

#### ASSESSMENT METHOD

Oral presentation of key scientific  
paper.

#### TEACHING AIDS

#### TEACHING LANGUAGE

English

#### CONTACT

M. BASKURT Atilla  
attila.baskurt@insa-lyon.fr

#### AIMS

A short introduction to image processing and information theory is done. Then this course focuses on multimedia processing (image, video and 3D). The methods which led to current standards, are first presented for image and video compression (JPEG, JPEG 2000, MPEG 1-2-4, H.264). An introduction to image and video indexing & retrieval and watermarking is then proposed. The presentation of main video processing techniques for object detection completes this course (video surveillance, video protection, video content analysis).

#### CONTENT

- Introduction to image processing
- Introduction to information theory
- Image coding: methods and standards
- Video coding: methods and standards
- Introduction to multimedia indexing and retrieval
- Introduction to multimedia watermarking
- Video processing techniques for scene analysis and object detection

#### BIBLIOGRAPHY

- [1] Anil K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989
- [2] Alan Hanjalic, Content-Based Analysis of Digital Video, Springer Verlag, 2004
- [3] Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer-Verlag, 2008
- [4] R.J. Clarke, 'Transform coding of images', Academic Press, ISBN 0-12-175730-7, 432 p., 1985.
- [5] Stéphane Mallat, 'A wavelet tour of signal processing', Academic Press, New York, 1998.
- [6] <http://www.vcodex.com/h264.html>
- [7] <http://mpeg.chiariglione.org/>

#### PRE-REQUISITE

It is important that the students have followed an introduction to signal processing or have knowledge in digital signal processing.

Last modification date : January 29, 2013

## Informatique

### Software Engineering

#### AIMS

The course presents the rules and practical methods related to production organization that is necessary to adopt in order to master the developing process of information technology systems.

It aims to guarantee the quality of software and facilitate project management in the respect of costs and deadlines.

#### CONTENT

The major points addressed are: Presentation of the overall framework of the software development processes (processes in V, Modeling processes / prototypes, progressive processes, the acquiring process of software packages, choice of subcontractors process, test and maintenance processes) replaced in a more general framework of system design.

In addition, this course will rely on the current norms (ISO 12207, Z67-111 (Modeling/Prototypes)...) and aims to sensitize students to the importance of a good definition of a future product (requirements, specifications), and to define the implementation of a methodological approach as far as conception. The course illustrates the existence of a multiplicity of development processes and the necessity of choice of the most adequate process for the problem raised.

An important part of the course will also focus on the test and validation of software and particularly:

- the techniques of test (the structural test or white box test, the functional test or black box test, software test in real time).
- integrating the strategies (top-down, bottom-up, mixed).
- early test planning in the development cycle.
- implementation problems.

#### BIBLIOGRAPHY

- [1] Pressman Roger. A practitioner's approach. Ottawa : Mc Graw Hill
- [2] Martin James. Rapid application development. Paris : MacMillan
- [3] Xanthakis Spyros, Reznier Pascal, Karapoulios Constantin. Le test des logiciels. Paris : Hermès
- [4] Bass Len, Clement Paul, Kazman Rick. Software Architecture in Practice. Canada : Addison Wesley

#### PRE-REQUISITE

Last modification date : July 20, 2012