

Master of Science  
Financial Computing

Description of courses

## Banking Software Design

The course, in which specialists from the finance & banking software industry take part in every lecture, presents all the phases in the design and development of complex software intended for a real-life environment, and conforming to real-life client needs.

The course aims to provide an overview on banking software design, by addressing aspects of advanced programs, dedicated and financial banking systems, software system, pattern oriented, database concepts and software systems architecture. Students will be able to:

- understand basic concepts of software development lifecycle
- explain how data is represented, manipulated and stored within a computer system
- design algorithms to solve some of the programming problems
- construct a design of a collection of modules and entities
- understand well known design patterns
- implement software solutions to one or more sets of problems
- develop software of high quality, that is reliable and easy to maintain
- work efficiently with limited resources
- make architectural design decisions
- understand basic concepts of software architecture
- understand the underlying structure and theories of computers and programming
- understand banking systems models

The course is grouped into several parts: requirements analysis and validation; service-oriented architectures; front-end design and implementation; back-end design and implementation; testing and quality assurance.

## Resources:

Software Architecture in Banking – JD Hill, Andrew R. Kruth, Joe Salisbury, Sam Varga

Software Architecture as a Set of Architectural Design Decisions – Anton Jansen, Jan Bosch

Software Systems Architecture – Nick Rozanski, Eoin Woods – 2009 – Safari Books Online, LLC

## Data Mining for Computational Finance

This course introduces technologies, methods, models, and algorithms for storing, modeling, and extracting knowledge. The course investigates various classes of problems and presents their specific algorithms. The focus of the course is threefold:

- Understand the use of supervised machine learning and data mining methods to create classification and prediction models;
- Understand the use of unsupervised machine learning methods and data mining to create grouping models;
- Understanding exploratory data analysis.

Chapters of the course comprise:

- Data Mining Introduction
- Data Processing
- Frequent Item Mining and Association Rules
- Supervised Learning: Decision Trees, Naive Bayes, K-Nearest Neighbor, Support Vector Machine, Ensemble Methods, Regression
- Unsupervised Learning: Centroid based clustering, Hierarchical clustering, Distribution-based clustering, Density-based clustering
- Information Retrieval Systems

## Banking System Software Life Cycle

The course provides an end-to-end view of IT and its integration with business strategy. It provides theoretical knowledge and practical skills in IT audit, its role in internal control and information security, practical recommendations for successful conduct and efficiency improvements of IT audit, practical skills in describing IT controls and actions to address information risks. It provides guidance on how to design, develop, and implement service management. It ensures that the overall business aims and strategy is supported by the IT organizations aims and strategy. It provides guidance on managing change along with risk and quality whilst ensuring IT Operations can manage those changes within the context of the ICT Infrastructure. It provides guidance on the day to day management of the ICT Infrastructure.

It also contributes to the Service Management Lifecycle for carrying out those processes which contribute to the optimization of the services provided.

The course has three parts. COBIT (Control Objectives for Information and Related Technology)<sup>1</sup> helps organizations meet business challenges in the areas of regulatory compliance, risk management and aligning IT strategy with organizational goals.

ITIL (formerly Information Technology Infrastructure Library) is a set of detailed practices for IT activities such as IT service management (ITSM) and IT asset management (ITAM) that focus on aligning IT services with the needs of business. ITIL describes processes, procedures, tasks, and checklists which are neither organization-specific nor technology-specific, but can be applied by an organization toward strategy, delivering value, and maintaining a minimum level of competency.

Finally, the Agile Management module does cover the need of an agile approach in a fast changing environment, the agile principles and a general overview of the Scrum methodology with roles, ceremonies and artifacts.

## Processes, products and services for finance and banking

The course presents the departments that exist in an investment bank and the basic processes and flows that exist between them. At the end of this course, students will have a good grasp on the available investment mechanisms and tools and will understand how their properties influence the evolution of their value.

The chapters of the course deal with: Banks, Treasury, Risk, Control Functions, Trade Life cycle, Private & Commercial Banking, Wealth & Asset Management, Investment Banking, Trading, Derivatives.

As a semester project, students must build a simulated investment portfolio that ensures variety and robustness.

## Self-discovery and Effective communication (soft skills)

This course is designed to help the students identify the right tools for having a clearer and more assertive communication style, become familiar with the different ways of communication, and increase student self-awareness. Starting from William Marsten's behavioural theory, the students will learn to identify their own behavioural and communication style and how to flex it, while communicating with

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<sup>1</sup><https://www.isaca.org/resources/cobit>

others.

The course covers several topics:

- Defining communication, types and forms of communication
- Personality types and behavioural styles theory
- Identify and learn how to use own behavioural style — how we communicate with each other, self-perception versus other’s perception
- Steps for having an effective communication (planning, understanding others, active listening)
- Feedback — definition, how to ask and receive feedback, the importance of feedback
- Active listening — what it is and how to develop active listening skills
- Types of communication (verbal, non-verbal, para-verbal)
- Communication barriers – identify the barriers and find ways of moving forward
- Difficult conversations; saying “no”; assertiveness by using the right language
- Team communication; group dynamic; communication within groups, roles, responsibilities
- Influencing skills; definition of concepts; learn how to influence other directly or indirectly
- Conflict management; definition of conflict, ways of approaching and addressing difficult situations
- Communicating in public; definition, concept, identifying ways of overcoming stress caused by public speaking
- Presentation skills — learn how to make effective presentations, content, structure, communicating the right message.

## Applied Human Computer Interaction

This course is designed to offer students a new perspective about designing products and it aims to achieve:

- Think differently about products
- Change the way we analyse ideas
- Understand users
- Tell stories from the user’s perspective
- Prototype new products
- Evaluate the experience

The courses will be based on the Interaction Design<sup>1</sup> textbook, one of the most popular teaching instruments in the field while during the lab students will work in teams passing through the steps to develop a new product from idea to prototype. Among the chapters of the course are: What is interaction design; The process of interaction design; Cognitive aspects; Social interaction; Data visualization; UI

Patterns; Prototyping; Evaluation.

## Big Data Analytics and Fundamentals

The course deals with the management of large data warehouses, design algorithms for large data sets and understand the appropriate cases in which analysis and search in large data warehouses are used. The chapters of the course are:

- Introduction in Big Data
- Steps in the Data Science Process
- Pre-processing techniques: clustering, cleaning, aggregation
- Models for distributed batch computing: MapReduce, Apache Hadoop, Apache Spark
- Machine Learning in Big Data
- Distributed file systems for batch computing: HDFS, Google File System
- Data storage systems: NoSQL, Distributed Hash Table, Apache/Facebook Cassandra

### Resources:

Mining of Massive Datasets by Anand Rajaraman and Jeffrey David Ullman, 2011

Data-Intensive Text Processing with MapReduce by Jimmy Lin and Chris Dyer Morgan, 2010

Hadoop Real World Solutions Cookbook by Jonathan R. Owens, Brian Femiano, and Jon Lentz Publication, 2013

Learning Spark: lightning-fast big data analysis by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia, 2015

## Industry Expert Lectures in Finance

Fintech has been described as the new Industrial Revolution as information technology is now driving innovation in the financial sector impacting all areas of the professional and personal financial world.

The banking and the whole financial industry are being revolutionized by informatics. Now modern banking is entirely run by software, technology is changing the way we handle money and financial markets are swept off their feet by cryptocurrencies.

The objective of the Industry Expert Lectures in Finance course is to combine the theoretical understanding and the practical skills that students have acquired during the first two semesters with insights from top players that are currently leading the way in the industry.

Students will get to understand the environment of Fintech and will learn how to solve complex problems that arise in real life situations in the industry by understanding the key players, stakeholders, trends, business models, history and resources available.

The course will be structured in two main directions:

- Give students insights of real life situations and problems of the industry by interacting with guest lecturers who are well known professionals in top rated companies and organizations like : Microsoft, Transfond, BNR, etc.
- Help students understand the challenges of the industry and the toughest work problems faced by different companies by using a set of immersive real world scenarios and case studies. The student will be the ones choosing the case studies from a wide range of proposed scenarios taken from the Harvard Business School library.

## Machine Learning and Computational Intelligence

The course offers in-depth knowledge on fundamental techniques for exploratory data analysis, data augmentation, feature representations and building, training and evaluating machine learning models for financial systems applications. The course comprises chapters dealing with:

- Introduction to machine learning
- Exploratory Data Analysis
- Regression Algorithms and Regularization
- Under/Over Sampling Techniques
- Support Vector Machines
- Artificial Neural Network Basics
- Multi Layer Perceptrons and Backpropagation
- Neural Network Optimization Techniques
- Neural Network Regularization and Training Stabilization Techniques
- Convolution Neural Networks Architectures and Applications
- Feature Initialization and Deep Normalization Techniques
- Recurrent Neural Network Architectures and Applications
- Generative Models: VAE and GAN
- Wasserstein Loss and Gradient Penalty