



## Executive Master Program

### Financial Engineering

*Data Science, Machine Learning and Predictive Analytics*

Technology + Management

The HECTOR School is the Technology Business School of the Karlsruhe Institute of Technology (KIT). It is named after Dr. Hans-Werner Hector, one of the co-founders of SAP SE.

The school aims to provide professionals with **state-of-the-art technological expertise and management know-how within part-time education programs**. The HECTOR School fosters lifelong learning within industry. Participants are supported in their career development with executive master degree programs, certificate courses, and customized partner programs.

The benefits of the executive master programs are numerous for participants as well as for the companies they work for:

- **Unique Holistic Approach:** A combination of technology expertise and management know-how.
- **State-of-the-Art Knowledge:** Direct transfer from the Karlsruhe Institute of Technology (KIT) research.
- **Part-Time Structure:** Allows participants to continue with their demanding careers whilst acquiring new skills.
- **Master Thesis to set up Innovation Projects:** Companies gain outstanding added value through the consultation of such projects by professors from KIT.
- **Excellent Networking Opportunities:** Professional networking is fostered across industries and on an international scale.



Portrait of the HECTOR School



## Key Facts: Part-Time Master of Science (M.Sc.) Programs

### Program Structure

- Part-time, 10 x 2-week modules
- Duration: part-time lecture period of ~15 months
- Master thesis: project work in the company, 6 months
- 5 Engineering and 5 Management Modules
- Teaching language: English
- Yearly program start: October

### Academic Degree

Master of Science (M.Sc.) from the KIT (90 ECTS)

### Admission Requirements

- A first academic degree: e.g. Bachelor, Master or Diploma
- At least 1-2 years work experience (depending on the level of the first degree, recommended > 3 years)
- If English is not your mother tongue nor has it been the language of instruction for the last five years, language proficiency is required, e.g. test certificate (e.g. TOEFL score of at least 570 PBT; 230 CBT; 90 iBT or IELTS at least 6,5 points) or appropriate proof of C1 level.

### Accreditation

The KIT is system-accredited by AAQ. All HECTOR School master programs are accredited by the internal quality assurance system of the KIT.



# Master Program

## Financial Engineering



Prof. Dr. Maxim Ulrich  
Chair of Financial Economics and Risk Management, KIT

Prof. Dr. Martin E. Ruckes  
Institute of Finance, Banking, and Insurance, KIT

### **Program Directors Financial Engineering**

*"We see modern Financial Engineering as the science of data-driven decision making in business environments. Building more accurate models reduces uncertainty around future events and paths the way to better decision making. It is a mix of broad decision-making applications, sound data and modeling work, paired with an entrepreneurial drive to solve innovation challenges using modern software and financial thinking, that makes our Master's Program in Financial Engineering a unique experience."*

Prof. Dr. Maxim Ulrich

We are living in an unprecedented era of rapidly growing data and computational power. Businesses across the globe adopt technology at an increasing rate. Individuals and institutions that are able to combine data, modeling, programming and decision-making encounter tremendous opportunities to add value to themselves, their institutions and society at large. We see modern Financial Engineering as the science of data-driven decision making in business environments. Building more accurate models reduces uncertainty around future events and paths the way to better decision making. Learning from data, using classical statistical concepts and novel concepts from machine learning help businesses across industries and geography to solve predictive data analytics and valuation problems. Today's predictive learning schemes perform tasks that were previously only solvable by a limited group of experts. Advances in predictive analytics and learning will affect all business models and industries. Financial tasks in particular, will be transformed at an astonishing fast pace. Vast amount of data, paired with the individuals and institutions desire to plan ahead to meet future obligations and investments make financial decision making in its broadest sense an especially appealing application of predictive analytics and learning schemes.

Our Master's program in Financial Engineering with a special focus on Data Science, Machine Learning and Predictive Analytics prepares decision makers to model and understand data across a variety of business fields and problems. The first two engineering modules teach fundamentals of finance, financial economics, data science and Python and pairs these with novel developments in the field of digital

business models, allowing our students to grasp the status-quo and business opportunities that arise in this lucrative business field. The third and fourth engineering modules introduce business decision makers to machine learning and engineering aspects to ground data-driven decision-making in hard science. The last engineering module is devoted to teach how alternative data, for example in the form of text data, and advances in machine learning can be used to innovate in tomorrow's business world. Most of these engineering modules are divided into a conceptual and into a hands-on computational part to allow our Master students to understand and work with predictive analytics and learning schemes in a variety of decision-making contexts. For the Master thesis, we encourage our students to aim high and to solve a data problem for individuals, institutions or society at large, using financial engineering and predictive analytics tools and modern software. We believe there is no better time to start your own data driven technology adventure than during your Master thesis. The vibrant technology environment of the KIT, together with the numerous businesses in the area of Karlsruhe, offer a rich pool of problems that wait to be solved.

The Financial Engineering Program shares five management modules with the other master programs. This fosters cross industry networking and provides the participants with cutting-edge knowledge in technology-driven innovation, strategy, data-driven marketing, international multi-project management, as well as international law, human resource management, people analytics, and different leadership approaches.

# Engineering Modules (EM)

Modeling and Understanding Data to Untap Hidden Value

DATA SCIENCE MACHINE LEARNING FOR  
BUSINESS AND FINANCE INNOVATIONS  
DATA-DRIVEN DECISION MAKING PYTHON  
CODING FOR MANAGERS ALTERNATIVE DATA  
AND NATURAL LANGUAGE PROCESSING  
WITH PYTHON PATTERN RECOGNITION WITH  
PYTHON DIGITAL FINANCIAL MARKETS  
WITH BLOCK-CHAIN AND CRYPTO  
COMPUTATIONAL QUANT FINANCE FINANCIAL  
AND RISK MANAGEMENT WITH PYTHON  
PREDICTIVE ANALYTICS FOR DATA-DRIVEN  
MANAGERS DATA-DRIVEN  
FINANCIAL ENGINEERING

## EM 1: Digital Financial Markets

The business world is changing rapidly as a result of unprecedented data and computational power. There are tremendous business opportunities for innovators who combine data, modeling and decision making. This module teaches a deeper understanding of financial markets and the business opportunities they offer. The module also covers topics of digitalization, block-chain, crypto currencies and Python programming.

## EM 2: Financial Economics for Data Scientists

Data is crucial in modern business and finance applications. Data science tools are powerful in detecting patterns. Yet, data scientists need domain knowledge in financial economics. Setting-up the data experiment, interpreting data findings and distinguishing informative signals from noise in data requires a sound understanding of financial economics. The first aim of this module, is therefore, to teach participants the fundamentals and advances of modern financial economics, containing topics from corporate finance, strategic finance, ethics in finance and the theory of value. The second aim is to teach students to view data science through a data and an algorithmic lens.

## EM 3: Machine Learning for Data-Driven Decision Making

This module teaches participants how machine learning can be used to result in better decision making and to untap hidden value in data. Machine learning concepts are first introduced to general business application and then circled in to finance problems. Cutting-edge machine learning tools are used to conduct more informed risk management, asset management and financial engineering.

## EM 4: Engineering Aspects of Financial Markets

Analytics from engineering has had a substantial impact on finance, especially in the fields of risk management, asset management and the pricing and hedging of derivatives. Engineering tools can help to extract meaning of complex finance data to support machines when aiming to detect patterns and relationships in sophisticated asset markets such as futures and derivatives markets. This module teaches the foundation of engineering tools that allow financial economics to move into financial engineering. Using these tools, students also learn about important no-arbitrage restrictions in futures and derivatives markets and how to exploit these with modern machine and data science approaches.



### EM 5: Alternative Data and Machine Learning for Business Applications

This module teaches how to work with alternative data and new advances in predictive data analytics and machine learning to contribute to future business and finance innovations. This module teaches current innovations that went from a niche to mainstream, such as Text as Data, Natural Language Processing and Deep Learning. This module teaches the theory of these approaches and provides business applications to highlight how these methods resulted in better decision making and value added for corporations and individuals.

#### Crash Course: Probability and Statistics

We highly recommend all applicants to participate in the course to update the technical knowledge, as it might be the crucial factor for a successful degree at HECTOR School.

## Engineering Modules

### EM 1: Digital Financial Markets

Courses: Global Financial Markets, Introduction to Python, Block-Chain Technology, Digital Currencies and Business Models

### EM 2: Financial Economics for Data Scientists

Courses: Financial Economics, Fundamentals of Financial Data Science

### EM 3: Machine Learning for Data-Driven Decision Making

Courses: Machine Learning for Decision Makers, Fundamentals of Financial Machine Learning, Kernel and Bayesian Methods in Machine Learning

### EM 4: Engineering Aspects of Financial Markets

Courses: Fundamentals of Financial Engineering, Derivatives and the Value of Optionality

### EM 5: Alternative Data and Machine Learning for Business Applications

Courses: Text Mining and Natural Language Processing, Advances in Machine Learning and Pattern Recognition

*Curriculum may be subject to change.*

# Management Modules (MM)

## Economic Know-How for Successful Managers



## Management Modules

### MM 1: Marketing & Information

Courses: Designing and Selling Solutions (incl. Negotiation Training), Information Systems Management, Big Data Methods, Legal Aspects of Information

### MM 2: Finance & Value

Courses: Management Accounting, Financial Accounting, Strategic Financial Management, Case Studies

### MM 3: Decisions & Risk

Courses: Decision Modeling, Risk Aware Decisions, Interactive Decisions, Robust and Stochastic Optimization

### MM 4: Innovation & Projects

Courses: Technology Driven Innovation, International Intellectual Property Law, Project Management, Multi-Project Management in an International Setting

### MM 5: Strategy & People

Courses: Strategic Management, Managerial Economics, Business Organization and Corporate Law, Strategic Human Resource Management, Leadership and Conflict Management



*Curriculum may be subject to change.*

Order your free course guide book with detailed contents of the Master's Program!

### MM 1: Marketing & Information

Many of today's most successful businesses excel in satisfying customer needs because their decisions are based on data instead of good feeling. This is what this module is about: One focus is on how to use data for designing customer solutions (and get paid according to their value) and the other focus is a more general one at issues surrounding the use of (big) data for business decision-making.

### MM 2: Finance & Value

Modern corporate governance is based on the creation of values. In the Finance & Value module, students learn essential methods of measuring, processing, and communicating the value added by corporate decisions that enable effective planning, management, and monitoring of corporate activity and corporate units. External value-based communication makes it possible to win stakeholders who are committed to the company over the long term.

### MM 3: Decisions & Risk

Management implies making decisions. A valid data warehouse forms the basis for these decisions. The aim of this module is to give students a toolkit of various quantitative decision-making models so that the possibilities and limitations of methodical decision-making support (among others also optimization methods) can be used efficiently in the day-to-day running of projects.

### MM 4: Innovation & Projects

Numerous paradigm shifts are currently being driven by the development and extensive use of new technologies. Profound changes in rapidly changing markets flow directly from this. Consequently, apart from classic project management, new management tools and methods are required because agility and innovation are some of the success factors in the current business climate. The module thus focuses on one of KIT's unique selling points: technology-driven innovation.

### MM 5: Strategy & People

The key to corporate success lies in the correct strategy. But how do you recognize opportunities, develop a viable concept, and successfully implement it? In times of scarce human capital, it is more important than ever before to ensure employees are a perfect fit for their position and to motivate them to implement the strategy together. The module imparts state-of-the-art management techniques and know-how on evidence-based human resources management, people analytics, and leadership approaches.

# A HECTOR School Master: Leadership Know-How for Demanding Careers.



»The Master's degree course in Financial Engineering imparts Game Changer knowledge. The current methods and application scenarios of Big Data and Data Analysis for topics such as Machine Learning and Artificial Intelligence change entire business models and they are part of the Program. Particularly noteworthy are the lectures about Financial Modelling with Python that cover theoretically models as well as the practical implementation. For many industries and finance departments today, the knowledge of Financial Econometrics imparted in the Master FE, is a key factor for future success and the application of statistical methods concerning capital markets, financial institutions and corporate finance & governance is important to control.«

Philipp Kunst, Financial Engineer Risk,  
Valuation and Simulation at BearingPoint GmbH



More Alumni Voices

## Academic Calendar

September 2021							October 2021							November 2021							December 2021										
Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun				
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MM Management Modules

EM Engineering Modules

Exams

Crash Course

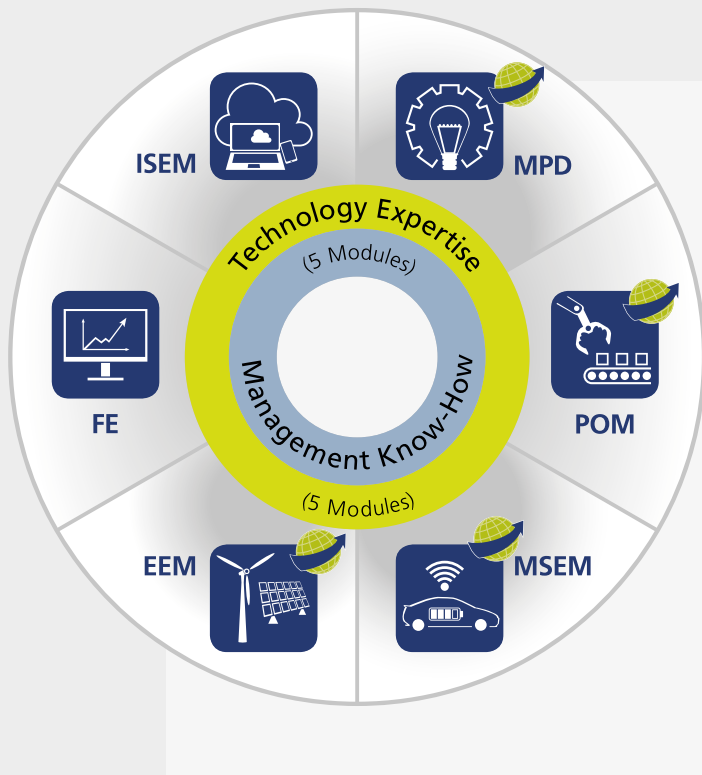
2-day seminar in "Probability and Statistics"

The academic calendar for each program starts annually in October. It consists of 10 modules, each with a duration of 2 weeks. All programs conclude with a master thesis.

>> Master Thesis: 6 months project work

Please note: Dates are subject to change.

# More Master Programs



## Six Part-Time Master of Science Programs in

- Energy Engineering & Management (EEM)
- Financial Engineering (FE)
- Information Systems Engineering & Management (ISEM)
- Management of Product Development (MPD)
- Mobility Systems Engineering & Management (MSEM)
- Production & Operations Management (POM)



Compact further education formats like Certificate Courses and more can be found in the HECTOR School Academy.



= International Module

## HECTOR School of Engineering & Management

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