# MODULE HANDBOOK

**Master of Science**

## Data Science (FI-MADS-120)

**120 ECTS**

**Distance Learning**

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

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2020-06-01

# 1. Semester

# Data Science

**Module Code: DLMBDSA1**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ulrich Kerzel (Data Science)

**Contributing Courses to Module**

- Data Science (DLMBDSA01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Introduction to data science
- Use cases and performance evaluation
- Pre-processing of data
- Processing of data
- Selected mathematical techniques
- Selected artificial intelligence techniques

**Learning Outcomes**

**Data Science**

On successful completion, students will be able to

- identify use cases and evaluate the performance of data-driven approaches
- comprehend how data are pre-processed in preparation for analysis.
- develop typologies for data and ontologies for knowledge representation.
- decide for appropriate mathematical algorithms to utilize data analysis for a given task.
- understand the value, applicability, and limitations of artificial intelligence for data analysis.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence. | All Master Programmes in the IT & Technology field. |

# Data Science

**Course Code: DLMBDSA01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The course Data Science provides the framework to create value from data. After an introduction the course covers how to identify suitable use cases and evaluate the performance of data-driven methods. The course covers techniques for the technical processing of data and then introduces advanced mathematical techniques and selected methods from artificial intelligence that are used to analyze data and make predictions.

**Course Outcomes**

On successful completion, students will be able to

- identify use cases and evaluate the performance of data-driven approaches
- comprehend how data are pre-processed in preparation for analysis.
- develop typologies for data and ontologies for knowledge representation.
- decide for appropriate mathematical algorithms to utilize data analysis for a given task.
- understand the value, applicability, and limitations of artificial intelligence for data analysis.

**Contents**

1. Introduction to Data Science
   - 1.1 Overview of Data Science
   - 1.2 Terms and Definitions
   - 1.3 Applications & Notable Examples
   - 1.4 Sources of Data
   - 1.5 Structured, Unstructured, Streaming
   - 1.6 Typical Data Sources and their Data Type
   - 1.7 The 4 V's of Data: Volume, Variety, Velocity, Veracity
   - 1.8 Introduction to Probability Theory
   - 1.9 What Are Probabilities and Probability Distributions
   - 1.10 Introduction to Bayesian Statistics
   - 1.11 Relation to Data Science: Prediction as a Probability

2. Use Cases and Performance Evaluation
   - 2.1 Identification of Use Cases for Data Science
   - 2.2 Identifying Data Science Use Cases
   - 2.3 From Prediction to Decision: Generating Value from Data Science
   - 2.4 Evaluation of Predictions
   - 2.5 Overview of Relevant Metrics
   - 2.6 Business-centric Evaluation: the Role of KPIs
   - 2.7 Cognitive Biases and Decision-making Fallacies

3. Pre-processing of Data
   - 3.1 Transmission of Data
   - 3.2 Data Quality and Cleansing of Data
   - 3.3 Transformation of Data (Normalization, Aggregation)
   - 3.4 Reduction of Data Dimensionality
   - 3.5 Data Visualisation

4. Processing of Data
   - 4.1 Stages of Data Processing
   - 4.2 Methods and Types of Data Processing
   - 4.3 Output Formats of Processed Data

5. Selected Mathematical Techniques
   - 5.1 Linear Regression
   - 5.2 Principal Component Analysis
   - 5.3 Clustering
   - 5.4 Time-series Forecasting
   - 5.5 Overview of Further Approaches

6. Selected Artificial Intelligence Techniques
   - 6.1 Support Vector Machines
   - 6.2 Neural Networks and Deep Learning
   - 6.3 Feed-forward Networks
   - 6.4 Recurrent Networks and Memory Cells
   - 6.5 Convolutional Networks
   - 6.6 Reinforcement Learning
   - 6.7 Overview of Further Approaches

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Akerar, R., & Sajja, P.S. (2016). Intelligent techniques for data science. Cham: Springer.<br>▪ Bruce, A., & Bruce, P. (2017). Practical statistics for data scientists: 50 essential concepts. Newton, MA: O'Reilly Publishers.<br>▪ Fawcett, T. & Provost, F. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. Newton, MA: O'Reilly Media.<br>▪ Hodeghatta, U. R., & Nayak, U. (2017). Business analytics using R – A practical approach. Berkeley, CA: Apress Publishing. (Database: ProQuest).<br>▪ Liebowitz, J. (2014). Business analytics: An introduction. Boca Raton, FL: Auerbach Publications. (Available online).<br>▪ Runkler, T. A. (2012). Data analytics: Models and algorithms for intelligent data analysis. Wiesbaden: Springer Vieweg.<br>▪ Skiena, S. S. (2017). The data science design manual. Cham: Springer. |

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Advanced Mathematics

**Module Code: DLMDSAM**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Eric Guiffo Kaigom (Advanced Mathematics)

**Contributing Courses to Module**

- Advanced Mathematics (DLMDSAM01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Calculus
- Integral transformations
- Vector algebra
- Vector calculus
- Matrices and vector spaces
- Information theory

**Learning Outcomes**

**Advanced Mathematics**

On successful completion, students will be able to

- remember the fundamental rules of differentiation and integration.
- apply integration and differentiation techniques to vectors and vector fields.
- analyze matrix equations.
- understand the generalization of vectors to tensors.
- evaluate different metrics from information theoretical perspectives.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field of Methods. | All Master Programmes in the Business & Management field. |

# Advanced Mathematics

**Course Code: DLMDSAM01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Modern techniques to analyze data and derive predictions for future events are deeply rooted in mathematical techniques.The course builds a solid base to understand the concepts behind advanced algorithms used to process, analyze, and predict data and observations and enables students to follow future research, especially in the fields of data-intensive sciences.The course reviews differentiation and integration and then discusses partial differentiation, differentiation, vector algebra and vector calculus. Matrix calculation and vector spaces are fundamental to many modern data processing algorithms and are discussed in detail. Calculations based on Tensors are introduced.Common metrics are discussed from an informational, theoretical point of view.

**Course Outcomes**

On successful completion, students will be able to

- remember the fundamental rules of differentiation and integration.
- apply integration and differentiation techniques to vectors and vector fields.
- analyze matrix equations.
- understand the generalization of vectors to tensors.
- evaluate different metrics from information theoretical perspectives.

**Contents**

1. Calculus
   - 1.1 Differentiation & Integration
   - 1.2 Partial Differentiation & Integration
   - 1.3 Vector Analysis
   - 1.4 Calculus of Variations
2. Integral Transformations
   - 2.1 Convolution
   - 2.2 Fourier Transformation
3. Vector Algebra
   - 3.1 Scalars and Vectors
   - 3.2 Addition, Subtraction of Vectors
   - 3.3 Multiplication of Vectors, Vector Product, Scalar Product

4. Vector Calculus
   - 4.1 Integration of Vectors
   - 4.2 Differentiation of Vectors
   - 4.3 Scalar and Vector Fields
   - 4.4 Vector Operators

5. Matrices and Vector Spaces
   - 5.1 Basic Matrix Algebra
   - 5.2 Determinant, Trace, Transpose, Complex, and Hermitian Conjugates
   - 5.3 Eigenvectors and Eigenvalues
   - 5.4 Diagonalization
   - 5.5 Tensors

6. Information Theory
   - 6.1 MSE
   - 6.2 Gini Index
   - 6.3 Entropy, Shannon Entropy, Kulback Leibler Distance
   - 6.4 Cross Entropy

**Literature**

**Compulsory Reading**

**Further Reading**


- Cover, T., & Joy, A. (2006). Elements of information theory (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.
- McKay, D. (2003). Information theory, inference and learning algorithms. Cambridge: Cambridge University Press.
- Riley, K. F., Hobson, M. P., & Bence, S. J. (2006). Mathematical methods for physics and engineering (3rd ed.). Cambridge: Cambridge University Press.
- Strang, G. (2016). Introduction to linear algebra. Wellesley, MA: Wellesley-Cambridge Press.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☑ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

DLMDSAM01

# Seminar: Data Science and Society

**Module Code: DLMDSSDSS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Tim Schlippe (Seminar: Data Science and Society)

**Contributing Courses to Module**

- Seminar: Data Science and Society (DLMDSSDSS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Fernstudium<br>Written Assessment: Research Essay | |

**Weight of Module**

see curriculum

**Module Contents**

In this module, students will reflect on current societal and political implications of the application of data science models. To this end, pertinent topics will be introduced via articles that are then critically evaluated by the students in the form of a written essay.

**Learning Outcomes**

**Seminar: Data Science and Society**

On successful completion, students will be able to

- name selected current societal topics and issues in data science.
- explain the influence and impact of data science on society and politcs.
- transfer theoretically-acquired knowledge to real-world cases.
- treat in a scientific manner a selected topic in the form of a written essay.
- critically question and discuss current societal and political issues arising from the application of data science techniques.
- develop own problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of data science.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Seminar: Data Science and Society

**Course Code: DLMDSSDSS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Applications of data science are becoming ubiquitous across virtually all forms of economic and social interaction. Credit rating, consumer behavior analysis, and news feed curation are but a few examples. In this seminar, some of the societal implications of these developments are examined. The course is complemented by several articles and case studies describing current examples of the impact of data science on society. The students learn to independently analyze selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.

**Course Outcomes**

On successful completion, students will be able to

- name selected current societal topics and issues in data science.
- explain the influence and impact of data science on society and politcs.
- transfer theoretically-acquired knowledge to real-world cases.
- treat in a scientific manner a selected topic in the form of a written essay.
- critically question and discuss current societal and political issues arising from the application of data science techniques.
- develop own problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of data science.

**Contents**

- The seminar covers current topics concerning the societal impact of data science. Each participant must write a seminar paper on a topic assigned to him/her.

**Literature**

**Compulsory Reading**

**Further Reading**


- Fry, H. (2018).
  Hello world: How to be human in the age of the machine
  . New York, NY: W. W. Norton & Co.
- Loukides, M., Mason, H., & Patil, D. J. (2018).
  Ethics and data science.
  Sebastopol, CA: O'Reilly Media.
- Muller, J. Z. (2018).
  Tyranny of metrics.
  Princeton, NJ: Princeton University Press.
- O'Neil, C. (2017).
  Weapons of math destruction: How big data increases inequality and threatens democracy.
  New York, NY: Crown Publishing Group.
- Wachter-Boettcher, S. (2017).
  Technically wrong: Sexist apps, biased algorithms, and other threats of toxic tech.
  New York, NY: W. W. Norton & Co.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Seminar |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Research Essay |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☐ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

DLMDSSDSS01

# Advanced Statistics

**Module Code: DLMDSAS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

N.N. (Advanced Statistics)

**Contributing Courses to Module**

- Advanced Statistics (DLMDSAS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Workbook | |

**Weight of Module**

see curriculum

**Module Contents**

- Introduction to statistics
- Important probability distributions and their applications
- Bayesian statistics
- Descriptive statistics
- Data visualization
- Parameter estimation
- Hypothesis tests

**Learning Outcomes**

**Advanced Statistics**

On successful completion, students will be able to

- understand the fundamental building blocks of statistics.
- analyze stochastic data in terms of the underlying probability distributions.
- utilize Bayesian statistics techniques.
- summarize the properties of observed data using descriptive statistics.
- apply data visualization techniques to design graphics that illustrate the behavior of observed data.
- evaluate model parameters using parameter estimation techniques.
- create hypothesis tests to discriminate between several model classes.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field of Methods. | All Master Programmes in the Business & Management field. |

# Advanced Statistics

**Course Code: DLMDSAS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM01 |

**Course Description**

Nearly all processes in nature and technical or scientific scenarios are not deterministic but stochastic. Therefore, these processes must be described in terms of probabilities and probability density distributions.After defining and introducing the fundamental concepts of statistics, the course will cover important probability distributions and their prevalence in application scenarios; discuss descriptive techniques to summarize and visualize data effectively; and discuss the Bayesian approach to statistics.Estimating parameters is a key ingredient in optimizing data models, and the course will give a thorough overview of the most important techniques.Hypothesis testing is a crucial aspect in establishing the observation of new effects and determination of the significance of statistical effects. Special focus will be given to the correct interpretation of p-Values and the correct procedure for multiple hypothesis tests.

**Course Outcomes**

On successful completion, students will be able to

- understand the fundamental building blocks of statistics.
- analyze stochastic data in terms of the underlying probability distributions.
- utilize Bayesian statistics techniques.
- summarize the properties of observed data using descriptive statistics.
- apply data visualization techniques to design graphics that illustrate the behavior of observed data.
- evaluate model parameters using parameter estimation techniques.
- create hypothesis tests to discriminate between several model classes.

**Contents**

1. Introduction to Statistics
   - 1.1 Random Variables
   - 1.2 Kolmogorov Axioms
   - 1.3 Probability Distributions
   - 1.4 Decomposing probability distributions
   - 1.5 Expectation Values and Moments
   - 1.6 Central Limit Theorem
   - 1.7 Sufficient Statistics
   - 1.8 Problems of Dimensionality
   - 1.9 Component Analysis and Discriminants

2. Important Probability Distributions and their Applications
   - 2.1 Binomial Distribution
   - 2.2 Gauss or Normal Distribution
   - 2.3 Poisson and Gamma-Poisson Distribution
   - 2.4 Weibull Distribution

3. Bayesian Statistics
   - 3.1 Bayes' Rule
   - 3.2 Estimating the Prior, Benford's Law, Jeffry's Rule
   - 3.3 Conjugate Prior
   - 3.4 Bayesian & Frequentist Approach

4. Descriptive Statistics
   - 4.1 Mean, Median, Mode, Quantiles
   - 4.2 Variance, Skewness, Kurtosis

5. Data Visualization
   - 5.1 General Principles of Dataviz/Visual Communication
   - 5.2 1D, 2D Histograms
   - 5.3 Box Plot, Violin Plot
   - 5.4 Scatter Plot, Scatter Plot Matrix, Profile Plot
   - 5.5 Bar Chart

6. Parameter Estimation
   - 6.1 Maximum Likelihood
   - 6.2 Ordinary Least Squares
   - 6.3 Expectation Maximization (EM)
   - 6.4 Lasso and Ridge Regularization
   - 6.5 Propagation of Uncertainties

7. Hypothesis Test
   - 7.1 Error of 1st and 2nd Kind
   - 7.2 Multiple Hypothesis Tests
   - 7.3 p-Value

**Literature**

**Compulsory Reading**

**Further Reading**


- Bishop, C. (2007). Pattern recognition and machine learning (2nd ed.). Singapore: Springer.
- Bruce, P., & Bruce, A. (2017). Statistics for data scientists: 50 essential concepts. Sebastopol, CA: O'Reilley Publishing.
- Downey, A. (2013). Think Bayes. Sebastopol, CA: O'Reilley Publishing.
- Downey, A. (2014). Think stats. Sebastopol, CA: O'Reilley Publishing.
- McKay, D. (2003). Information theory, inference and learning algorithms. Cambridge: Cambridge University Press.
- Reinhart, A. (2015). Statistics done wrong. San Francisco, CA: No Starch Press.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Workbook |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☑ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# Use Case and Evaluation

**Module Code: DLMDSUCE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ulrich Kerzel (Use Case and Evaluation)

**Contributing Courses to Module**

- Use Case and Evaluation (DLMDSUCE01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Fernstudium<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Use case evaluation
- Model-centric evaluation
- Business-centric evaluation
- Monitoring
- Avoiding common fallacies
- Change management

**Learning Outcomes**

**Use Case and Evaluation**

On successful completion, students will be able to

- analyze use cases and their requirements regarding the project objectives.
- apply common metrics to evaluate predictions.
- evaluate key performance indicators to asses projects from a business perspective.
- create monitoring tools that can be used to constantly evaluate the status quo of a project.
- understand common fallacies and how to avoid them.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Use Case and Evaluation

**Course Code: DLMDSUCE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The evaluation and definition of use cases is the fundamental groundwork from which the projects can be defined. This does not only include the scope and technical requirements of a project but also how value can be derived from the project. A crucial aspect is the definition of what makes a project successful, both in terms of a technical evaluation as well as a business centric perspective and how the status quo can be monitored effectively during the progress of a project. The course also discusses how to avoid common fallacies and understand the implications of introducing data-driven decisions into traditional management structures.

**Course Outcomes**

On successful completion, students will be able to

- analyze use cases and their requirements regarding the project objectives.
- apply common metrics to evaluate predictions.
- evaluate key performance indicators to asses projects from a business perspective.
- create monitoring tools that can be used to constantly evaluate the status quo of a project.
- understand common fallacies and how to avoid them.

**Contents**

1. Use Case Evaluation
   - 1.1 Identification of Use Cases
   - 1.2 Specifying Use Case Requirements
   - 1.3 Data Sources and Data Handling Classification
2. Model-centric Evaluation
   - 2.1 Common Metrics for Regression and Classification
   - 2.2 Visual Aides
3. Business-centric Evaluation
   - 3.1 Cost Function and Optimal Point Estimators
   - 3.2 Evaluation Using KPIs
   - 3.3 A/B Test

4. Monitoring
   - 4.1 Visual Monitoring Using Dashboards
   - 4.2 Automated Reporting and Alerting

5. Avoiding Common Fallacies
   - 5.1 Cognitive Biases
   - 5.2 Statistical Effects
   - 5.3 Change Management: Transformation to a Data-driven Company

**Literature**

**Compulsory Reading**

**Further Reading**


- Few, S. (2013). Information dashboard design: Displaying data for at-a-glance monitoring (2nd ed.). Burlingame, CA: Analytics Press.
- Gilliland, M., Tashman, L., & Sglavo, U. (2016). Business forecasting: Practical problems and solutions. Hoboken, NJ: John Wiley & Sons.
- Hyndman, R. (2018). Forecasting: Principles and practices (2nd ed.). OTexts.
- Kahneman, D. (2012). Thinking, fast and slow. London: Penguin.
- Parmenter, D. (2015). Key Performance Indicators (KPI): Developing, implementing, and using winning KPIs (3rd ed.). Hoboken, NJ: John Wiley & Sons.

### Study Format Fernstudium

| **Study Format** | **Course Type** |
|---|---|
| Fernstudium | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

DLMDSUCE01

# Project: Data Science Use Case

**Module Code: DLMDSPDSUC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLMDSUCE01 | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Thomas Zöller (Project: Data Science Use Case)

**Contributing Courses to Module**

- Project: Data Science Use Case (DLMDSPDSUC01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Fernstudium<br>Portfolio | |

**Weight of Module**

see curriculum

**Module Contents**

A current list of topics is given in the Learning Management System. This forms the basis of the course but can be amended or updated by the tutor.

**Learning Outcomes**

**Project: Data Science Use Case**

On successful completion, students will be able to

- apply the concepts covered in the preceding data science courses to build a running analytical model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real case studies.
- translate the learned theories into the practice of data science system building.
- critically evaluate the resulting model or system's performance

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Project: Data Science Use Case

**Course Code: DLMDSPDSUC01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSUCE01 |

**Course Description**

In this course, students choose a project task in accord with their tutor from a variety of options. The goal is to prototypically implement a data science model or system in a suitable development environment. The choice of approach, the system or software implemented, and the resulting performance on the task are to be reasoned about, explained, and documented in a project report. To this end, students make practical use of the methodological knowledge acquired in previous courses by applying them to relevant real-world problems.

**Course Outcomes**

On successful completion, students will be able to

- apply the concepts covered in the preceding data science courses to build a running analytical model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real case studies.
- translate the learned theories into the practice of data science system building.
- critically evaluate the resulting model or system's performance

**Contents**

- In this project course the students work on a practical implementation of a data science use case of their choosing. All relevant artifacts like use case evaluation, chosen implementation method, code, and outcomes are to be documented in the form of a written project report.

**Literature**

**Compulsory Reading**

**Further Reading**


- Few, S. (2013). Information dashboard design: Displaying data for at-a-glance monitoring (2nd ed.). Burlingame, CA: Analytics Press.
- Gilliland, M., Tashman, L., & Sglavo, U. (2016). Business forecasting: Practical problems and solutions. Hoboken, NJ: John Wiley & Sons.
- Hyndman, R. (2018). Forecasting: Principles and practices (2nd ed.). OTexts.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☑ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# 2. Semester

# Programming with Python

**Module Code: DLMDSPWP**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr.-Ing. Reza Shahbazfar (Programming with Python)

**Contributing Courses to Module**

- Programming with Python (DLMDSPWP01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Fernstudium<br>Written Assessment: Written Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Introduction to the Python programming language
- Object-oriented concepts in Python
- Handling of exceptions and errors
- The Python library ecosystem
- Environments and package management
- Documentation and testing
- Version control

**Learning Outcomes**

**Programming with Python**

On successful completion, students will be able to

- remember basic Python syntax and programming concepts.
- understand object-oriented concepts in Python.
- analyze and apply different methods for error handling in Python.
- know common and important Python libraries and how to apply them to given programming tasks.
- understand concepts like environments and version control.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence. | All Master Programmes in the IT & Technology field. |

# Programming with Python

**Course Code: DLMDSPWP01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Python is one of the most versatile and widely used scripting languages. Its clean and uncluttered syntax as well as its straightforward design greatly contribute to this success and make it an ideal language for programming education. Its application ranges from web development to scientific computing. Especially in the fields of data science and artificial intelligence, it is the most common programming language supported by all major data-handling and analytical frameworks. This course provides a thorough introduction to the language and its main features, as well as insights into the rationale and application of important adjacent concepts such as environments, testing, and version control.

**Course Outcomes**

On successful completion, students will be able to

- remember basic Python syntax and programming concepts.
- understand object-oriented concepts in Python.
- analyze and apply different methods for error handling in Python.
- know common and important Python libraries and how to apply them to given programming tasks.
- understand concepts like environments and version control.

**Contents**

1. Introduction to Python
   - 1.1 Data structures
   - 1.2 Functions
   - 1.3 Flow control
   - 1.4 Input / Output
   - 1.5 Modules & packages
2. Classes and inheritance
   - 2.1 Scopes and namespaces
   - 2.2 Classes and inheritance
   - 2.3 Iterators and generators

3. Errors and exceptions
   - 3.1 Syntax errors
   - 3.2 Handling and raising exceptions
   - 3.3 User-defined exceptions

4. Important libraries
   - 4.1 Standard Python library
   - 4.2 Scientific calculations
   - 4.3 Speeding up Python
   - 4.4 Visualization
   - 4.5 Accessing databases

5. Working with Python
   - 5.1 Virtual environments
   - 5.2 Managing packages
   - 5.3 Unit and integration testing
   - 5.4 Documenting code

6. Version control
   - 6.1 Introduction to version control
   - 6.2 Version control with GIT

**Literature**

**Compulsory Reading**

**Further Reading**


- Beazley, D., & Jones, B. K. (2013). Python cookbook (3rd ed.). Sebastopol, CA: O'Reilly Publishing.
- Barry, P. (2016). Head first Python: A brain-friendly guide (2nd ed.). Sebastopol, CA: O'Reilly Publishing.
- Lutz, M. (2013). Learning Python. Sebastopol, CA: O'Reilly Publishing.
- Ramalho, L. (2015). Fluent Python: Clear, concise, and effective programming. Sebastopol, CA: O'Reilly Publishing.
- McKinney, W. (2017). Python for data analysis (2nd ed.). Sebastopol, CA: O'Reilly Publishing.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Written Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Machine Learning

**Module Code: DLMDSML**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLMDSAM01,<br>DLMDSPWP01 | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Thomas Zöller (Machine Learning)

**Contributing Courses to Module**

- Machine Learning (DLMDSML01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam | |

**Weight of Module**

see curriculum

**Module Contents**

- Supervised, unsupervised, and reinforcement learning approaches
- Regression and classification learning problems
- Estimation of functional dependencies via regression techniques
- Data clustering
- Support vector machines, large margin classification
- Decision tree learning

**Learning Outcomes**

**Machine Learning**

On successful completion, students will be able to

- know different machine learning model classes.
- comprehend the difference between supervised, unsupervised, and reinforcement learning methods.
- understand common machine learning models.
- analyze trade-offs in the application of different models.
- appropriately choose machine learning models according to a given task.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Machine Learning

**Course Code: DLMDSML01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM01, DLMDSPWP01 |

**Course Description**

Machine learning is a field of scientific study concerned with algorithmic techniques that enable machines to learn performance on a given task via the discovery of patterns or regularities in exemplary data. Consequently, its methods commonly draw upon a statistical basis in conjunction with the computational capabilities of modern computing hardware. This course aims to acquaint the student with the main branches of machine learning and provide a thorough introduction to the most widely used approaches and methods in this field.

**Course Outcomes**

On successful completion, students will be able to

- know different machine learning model classes.
- comprehend the difference between supervised, unsupervised, and reinforcement learning methods.
- understand common machine learning models.
- analyze trade-offs in the application of different models.
- appropriately choose machine learning models according to a given task.

**Contents**

1. Introduction to Machine Learning
   - 1.1 Regression & Classification
   - 1.2 Supervised & Unsupervised Learning
   - 1.3 Reinforcement Learning
2. Clustering
   - 2.1 Introduction to clustering
   - 2.2 K-Means
   - 2.3 Expectation Maximization
   - 2.4 DBScan
   - 2.5 Hierarchical Clustering

3. Regression
   - 3.1 Linear & Non-linear Regression
   - 3.2 Logistic Regression
   - 3.3 Quantile Regression
   - 3.4 Multivariate Regression
   - 3.5 Lasso & Ridge Regression

4. Support Vector Machines
   - 4.1 Introduction to Support Vector Machines
   - 4.2 SVM for Classification
   - 4.3 SVM for Regression

5. Decision Trees
   - 5.1 Introduction to Decision Trees
   - 5.2 Decision Trees for Classification
   - 5.3 Decision Trees for Regression

6. Genetic Algorithms
   - 6.1 Introduction to Genetic Algorithms
   - 6.2 Applications of Genetic Algorithms

**Literature**

**Compulsory Reading**

**Further Reading**


- Bishop, C. M. (2011). Pattern recognition and machine learning. New York, NY: Springer.
- Efron, B., & Hastie, T. (2016). Computer age statistical inference. Cambridge: Cambridge University Press.
- Muller, A. C., & Guido, S. (2016). Introduction to machine learning with Python. Sebastopol, CA: O'Reilly.
- VanderPlas, J. (2017). Python data science handbook. Sebastopol, CA: O'Reilly Publishing.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

DLMDSML01

# Deep Learning

**Module Code: DLMDSDL**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLMDSAM01,<br>DLMDSPWP01,<br>DLMDSML01 | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Thomas Zöller (Deep Learning)

**Contributing Courses to Module**

- Deep Learning (DLMDSDL01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Introduction to neural networks and deep earning
- Network architectures
- Neural network training
- Alternative training methods
- Further network architectures

**Learning Outcomes**

**Deep Learning**

On successful completion, students will be able to

- comprehend the fundamental building blocks of neural networks.
- understand concepts in deep learning.
- analyze the relevant deep learning architecture in a wide range of application scenarios.
- create deep learning models.
- utilize alternative methods to train deep learning models.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Deep Learning

**Course Code: DLMDSDL01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM01, DLMDSPWP01, DLMDSML01 |

**Course Description**

Neural networks and deep learning approaches have revolutionized the fields of data science and artificial intelligence in recent years, and applications built on these techniques have reached or surpassed human performance in many specialized applications.After a short review of the origins of neural networks and deep learning, this course will cover the most common neural network architectures and discuss in detail how neural networks are trained using dedicated data samples, avoiding common pitfalls such as overtraining.The course includes a detailed overview of alternative methods to train neural networks and further network architectures which are relevant in a wide range of specialized application scenarios.

**Course Outcomes**

On successful completion, students will be able to

- comprehend the fundamental building blocks of neural networks.
- understand concepts in deep learning.
- analyze the relevant deep learning architecture in a wide range of application scenarios.
- create deep learning models.
- utilize alternative methods to train deep learning models.

**Contents**

1. Introduction to Neural Network and Deep Learning
   - 1.1 The Biological Brain
   - 1.2 Perceptron and Multi-Layer Perceptrons
2. Network Architectures
   - 2.1 Feed-Forward Networks
   - 2.2 Convolutional Networks
   - 2.3 Recurrent Networks, Memory Cells and LSTMs
3. Neural Network Training
   - 3.1 Weight Initialization and Transfer Function
   - 3.2 Backpropagation and Gradient Descent
   - 3.3 Regularization and Overtraining

4. Alternative Training Methods
   - 4.1 Attention
   - 4.2 Feedback Alignment
   - 4.3 Synthetic Gradients
   - 4.4 Decoupled Network Interfaces

5. Further Network Architectures
   - 5.1 Generative Adversarial Networks
   - 5.2 Autoencoders
   - 5.3 Restricted Boltzmann Machines
   - 5.4 Capsule Networks
   - 5.5 Spiking Networks

**Literature**

**Compulsory Reading**

**Further Reading**


- Chollet, F. (2017). Deep learning with Python. Shelter Island, NY: Manning.
- Efron, B., & Hastie, T. (2016). Computer age statistical inference. Cambridge: Cambridge University Press.
- Geron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow. Boston, MA: O'Reilly Publishing.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. Boston, MA: MIT Press.
- Russel, S., & Norvig, P. (2010). Artificial intelligence – A modern approach (3rd ed.). Essex: Pearson.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☐ Vodcast
- ☑ Shortcast
- ☑ Audio
- ☐ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☑ Guideline
- ☑ Live Tutorium/Course Feed

DLMDSDL01

# Big Data Technologies

**Module Code: DLMDSBDT**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Thomas Zöller (Big Data Technologies)

**Contributing Courses to Module**

- Big Data Technologies (DLMDSBDT01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Data types and data sources
- Databases
- Modern storage frameworks
- Data formats
- Distributed computing

**Learning Outcomes**

**Big Data Technologies**

On successful completion, students will be able to

- identify the different types and sources of data.
- understand different database concepts.
- build new database structures.
- evaluate various data storage frameworks w.r.t. project requirements.
- analyze which data format to use for a given project.
- create a distributed computing environment for a given project.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence. | All Master Programmes in the IT & Technology field. |

# Big Data Technologies

**Course Code: DLMDSBDT01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Data are often considered the “new oil”, the raw material from which value is created. To harness the power of data, the data need to be stored and processed on a technical level. This course introduces the four “Vs” of data, as well as typical data sources and types. This course then discusses how data are stored in databases. Particular focus is given to database structures and different types of databases, e.g., relational, noSQL, NewSQL, and time-series.Beyond classical and modern databases, this course covers a wide range of storage frameworks such as distributed filesystems, streaming, and query frameworks. This is complemented by a detailed discussion of data storage formats ranging from classical approaches such as CSV and HDF5 to more modern approaches like Apache Arrow and Parquet.Finally, this course gives an overview of distributed computing environments based on local clusters, cloud computing facilities, and container-based approaches.

**Course Outcomes**

On successful completion, students will be able to

- identify the different types and sources of data.
- understand different database concepts.
- build new database structures.
- evaluate various data storage frameworks w.r.t. project requirements.
- analyze which data format to use for a given project.
- create a distributed computing environment for a given project.

**Contents**

1. Data Types and Data Sources
   - 1.1 The 4Vs of data: volume, velocity, variety, veracity
   - 1.2 Data sources
   - 1.3 Data types
2. Databases
   - 2.1 Database structures
   - 2.2 Introduction to SQL
   - 2.3 Relational databases
   - 2.4 nonSQL, NewSQL databases
   - 2.5 Timeseries DB

3. Modern data storage frameworks
   - 3.1 Distributed Filesystems
   - 3.2 Streaming frameworks
   - 3.3 Query frameworks

4. Data formats
   - 4.1 Traditional data exchange formats
   - 4.2 Apache Arrow
   - 4.3 Apache Parquet

5. Distributed Computing
   - 5.1 Cluster-based approaches
   - 5.2 Containers
   - 5.3 Cloud-based approaches

**Literature**

**Compulsory Reading**

**Further Reading**


- Date, C. J. (2012). Database design and relational theory: Normal forms and all that jazz. Sebastopol, CA: O'Reilly Publishing.
- Karau, H., Konwinski, A., Wendell, A., & Zaharia, M. (2015). Learning spark: Lightning-fast data analysis. Sebastopol, CA: O'Reilly Publishing.
- Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide: Real-time data and stream processing at scale. Sebastopo, CA: O'Reilly Publishing.
- Poulton, N. (2017). Docker deep dive. Nigel Poulton.
- Psaltis, A. (2017). Streaming data: Understanding the real-time pipeline. Shelter Island, NY: Manning Publications.
- Redmond, E., & Wilson, J. R. (2012). Seven databases in seven weeks: A guide to modern databases and the noSQL movement. Dallas, TX: Pragmatic Bookshelf.
- Sadalage, P., & Fowler, M. (2012). NoSQL distilled: A brief guide to the emerging world of polyglot persistence. Ann Arbor, MI: Addison-Wesley.
- Viescas, J., & Hernandez, M. (2014). SQL queries for mere mortals: A hands-on guide to data manipulation in SQL, (3rd ed.). Ann Arbor, MI: Addison-Wesley.
- White, T. (2015). Hadoop: The definitive guide: Storage and analysis at Internet scale. Sebastopol, CA: O'Reilly Publishing.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** yes |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

DLMDSBDT01

# Data Science Specialist

**Module Code: DLMDSEDSS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | ▪ none<br>▪ DLMBMMIIT02 | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Leonardo Riccardi (Manufacturing Methods Industry 4.0) / Dr. Friedrich Morlock (Project: Data Science for Industry 4.0)

**Contributing Courses to Module**

- Manufacturing Methods Industry 4.0 (DLMBMMIIT02)
- Project: Data Science for Industry 4.0 (DLMDSEDSS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Manufacturing Methods Industry 4.0<br>• Study Format "Distance Learning": Exam, 90 Minutes<br>Project: Data Science for Industry 4.0<br>• Study Format "Fernstudium": Portfolio |

**Weight of Module**

see curriculum

**Module Contents**

**Manufacturing Methods Industry 4.0**

- Forming
- Cutting
- Rapid prototyping
- Rapid tooling
- Direct manufacturing

**Project: Data Science for Industry 4.0**

In preparation of a portfolio, students will apply data science to manufacturing scenarios; use predictive analytics to improve industrial processes; and gain an understanding of the principles and applications of predictive maintenance.

**Learning Outcomes**

**Manufacturing Methods Industry 4.0**

On successful completion, students will be able to

- evaluate different manufacturing methods against given product and process requirements.
- define and design modern additive techniques in contrast to traditional manufacturing.
- assess and estimate the impact of current trends on manufacturing like cyber-physical systems to given manufacturing challenges and practical problems.
- apply modern processes like rapid prototyping, rapid tooling, and direct manufacturing.

**Project: Data Science for Industry 4.0**

On successful completion, students will be able to

- identify where data science can be beneficial for manufacturing in the era of Industry 4.0.
- formulate related manufacturing issues in the data science formalism in order to prepare a solution.
- apply data science methods to realistic manufacturing scenarios.
- find and implement strategies to improve manufacturing processes.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Computer Science & Software Development and Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Manufacturing Methods Industry 4.0

**Course Code: DLMBMMIIT02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The aim of the course is to enable students to evaluate and identify appropriate manufacturing methods in the context of Industry 4.0. For that purpose, the course provides a comprehensive introduction of such processes based on traditional, standardized manufacturing techniques that have influenced and are still influencing production processes through technological developments under the generic term Industry 4.0. These include technological advances in additive manufacturing processes that enable applications such as rapid prototyping, rapid tooling, and direct manufacturing. Finally, the course deals with the consequences of the digitization and networking of production facilities and their elements in terms of a cyber-physical system.

**Course Outcomes**

On successful completion, students will be able to

- evaluate different manufacturing methods against given product and process requirements.
- define and design modern additive techniques in contrast to traditional manufacturing.
- assess and estimate the impact of current trends on manufacturing like cyber-physical systems to given manufacturing challenges and practical problems.
- apply modern processes like rapid prototyping, rapid tooling, and direct manufacturing.

**Contents**

1. Introduction to Manufacturing Methods
   - 1.1 Basic Concepts
   - 1.2 Historical Development of Manufacturing
   - 1.3 About the Long Tail
2. Manufacturing Methods
   - 2.1 Casting and Molding
   - 2.2 Shaping
   - 2.3 Machining
   - 2.4 Joining
   - 2.5 Coating

3. Additive Manufacturing and 3D printing
   - 3.1 Basics and Legal Aspects
   - 3.2 Material Extrusion
   - 3.3 Vat Polymerization
   - 3.4 Powder Bed Fusion
   - 3.5 Material Jetting
   - 3.6 Binder Jetting
   - 3.7 Direct Energy Deposition
   - 3.8 Sheet Lamination

4. Rapid Prototyping
   - 4.1 Definitions
   - 4.2 Strategical and Operative Aspects
   - 4.3 Application Scenarios

5. Rapid Tooling
   - 5.1 Definitions
   - 5.2 Direct and Indirect Methods
   - 5.3 Application Scenarios

6. Direct/Rapid Manufacturing
   - 6.1 Potentials and Requirements
   - 6.2 Implementation Examples

7. Cyber-Physical Production Systems
   - 7.1 Introduction
   - 7.2 Cyber-Physical Production Systems
   - 7.3 Impact on Design and Maintenance of Plants
   - 7.4 Dynamic Reconfiguration of Plants
   - 7.5 Application Examples

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Anderson, C. (2012). Makers. The new industrial revolution. New York, NY: Crown Business.<br>▪ Gebhardt, A. (2012). Understanding additive manufacturing. Rapid prototyping – Rapid tooling – Rapid manufacturing. Munich: Hanser.<br>▪ Groover, Mikell P. (2012). Fundamentals of modern manufacturing: Materials, processes, and systems. Hoboken, NJ: John Wiley & Sons Inc. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☐ Vodcast
- ☑ Shortcast
- ☑ Audio
- ☑ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☐ Guideline
- ☐ Live Tutorium/Course Feed

# Project: Data Science for Industry 4.0

**Course Code: DLMDSEDSS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMBMMIIT02 |

**Course Description**

The area of manufacturing is undergoing considerable change due to the development of key technologies in data science and the use of machine learning and artificial intelligence. The focus of this course is how to improve the performance of manufacturing processes by adopting data science methods and using knowledge of manufacturing methods. The main topics addressed include: predictive analytics for overproduction, idle time, logistics, and inventory; fault prediction and predictive maintenance; demand forecasting; and price optimization.Over the duration of this course, students will work through the phases of a data science-based project in theory and practice.

**Course Outcomes**

On successful completion, students will be able to

- identify where data science can be beneficial for manufacturing in the era of Industry 4.0.
- formulate related manufacturing issues in the data science formalism in order to prepare a solution.
- apply data science methods to realistic manufacturing scenarios.
- find and implement strategies to improve manufacturing processes.

**Contents**

- The course covers the applications of data science to manufacturing environments for Industry 4.0. The main fields of interest are predictive analytics for overproduction, idle time, logistics, and inventory; fault prediction and predictive maintenance; demand forecasting; and price optimization.

**Literature**

**Compulsory Reading**

**Further Reading**


- Abbott, D. (2014).
  Applied predictive analytics: Principles and techniques for the professional data analyst
  . Indianapolis, IN: John Wiley & Sons.
- Chu, L. P. (2016).
  Data Science for modern manufacturing
  . Retrieved from https://www.oreilly.com/library/view/data-science-for/9781492042686/
- Naskos, A., Gounaris, A., Metaxa, I., & Köchling, D. (2019). Detecting anomalous behavior towards predictive maintenance. In H. A. Proper & J. Stirna (Eds.),
  Advanced information systems engineering workshops
  (pp. 73–82). Cham: Springer International Publishing.
- Zenisek, J., Wolfartsberger, J., Sievi, C., & Affenzeller, M. (2019). Modeling sensor networks for predictive maintenance. In C. Debruyne, H. Panetto, W. Guedria, P. Bollen, I. Ciuciu, & R. Meersman (Eds.),
  On the Move to Meaningful Internet Systems: OTM 2018 Workshops
  . OTM 2018. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) (11231 LNCS), 184–188. Cham: Springer.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☑ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

DLMDSEDSS01

# Technical Project Lead

**Module Code: DLMDSETPL**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Inga Schlömer (IT Project Management) / Prof. Dr. Inga Schlömer (Project: Technical Project Planning)

**Contributing Courses to Module**

- IT Project Management (DLMBITPAM01)
- Project: Technical Project Planning (DLMDSETPL01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | IT Project Management<br>• Study Format "Distance Learning": Exam<br>Project: Technical Project Planning<br>• Study Format "Fernstudium": Portfolio |

**Weight of Module**

see curriculum

**Module Contents**

**IT Project Management**

- Organizing the work
- Cost estimation and controlling
- The human factor
- Organizing small, medium, and large projects

**Project: Technical Project Planning**

In this course, students learn to apply the project management concepts they learned in previous modules in a real-world project.

**Learning Outcomes**

**IT Project Management**

On successful completion, students will be able to

- critically reflect the status of knowledge on IT project management.
- set up different IT project management formats (small, medium and large projects) and know the methods for managing these different IT projects professionally.
- develop an IT management proposal as the fundament of a professional IT project management concept.
- understand and integrate different IT management project plans (e.g., time plan, cost plan, resources plan, risk plan) and use those plans in an integrative IT project planning and controlling scheme.
- organize and to lead an IT project team and its core and/or extended team members.

**Project: Technical Project Planning**

On successful completion, students will be able to

- apply the concepts of project management to real-world tasks and problems.
- translate the learned theories into the practice of project management.
- analyze a real-world problem and define and implement a project to resolve it.
- appraise the results of a project performed and identify what worked well and what did not.
- explain the work they perform, give its scientific background, and produce adequate documentation.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Computer Science & Software Development and Data Science & Artificial Intelligence. | All Master Programmes in the IT & Technology field. |

# IT Project Management

**Course Code: DLMBITPAM01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The purpose of this course is to introduce students to the concepts involved in IT project management. This is achieved through the development of an understanding of the fundamental tenets of project management enhancing the students' ability to apply their knowledge, skills and competencies in analyzing and solving IT project management problems. A special focus is put on the specifics of IT project organization, cost management and the human factor within IT projects.

**Course Outcomes**

On successful completion, students will be able to

- critically reflect the status of knowledge on IT project management.
- set up different IT project management formats (small, medium and large projects) and know the methods for managing these different IT projects professionally.
- develop an IT management proposal as the fundament of a professional IT project management concept.
- understand and integrate different IT management project plans (e.g., time plan, cost plan, resources plan, risk plan) and use those plans in an integrative IT project planning and controlling scheme.
- organize and to lead an IT project team and its core and/or extended team members.

**Contents**

1. Introduction: Characteristics of IT Projects
   - 1.1 Defining IT Projects
   - 1.2 Overview on Typical Roles and Phases of IT Projects
   - 1.3 Risks and Challenges of IT Projects
   - 1.4 Role of an IT Project Manager
2. Organizing the Work
   - 2.1 Project Breakdown Structure, Work Packages
   - 2.2 Prioritization
   - 2.3 Time Planning, Milestones, Gantt-Diagram
   - 2.4 Definition of Done

3. Cost Estimation and Controlling
   - 3.1 Challenges of Cost Estimation in IT Projects
   - 3.2 Estimation Techniques: 3-Point Estimation, Double Blind Expert Estimation, Function Points
   - 3.3 Cost Controlling Using Earned Value Analysis
   - 3.4 Risk Management

4. The Human Factor
   - 4.1 Vision Keeping
   - 4.2 Stakeholder Management
   - 4.3 Conflict Management

5. Organizing Small and Medium Projects
   - 5.1 Rational Unified Process (RUP)
   - 5.2 Agile Software Processes
   - 5.3 Scrum
   - 5.4 Plan-driven Project Management in Small Projects

6. Organizing Large Projects
   - 6.1 PMBOK Guide
   - 6.2 Prince2
   - 6.3 Multi Project Management
   - 6.4 Agile Software Processes in Large Projects
   - 6.5 Selection of the Appropriate Project Management Method

**Literature**

**Compulsory Reading**

**Further Reading**


- Stephens, R. (2015). Beginning software engineering. Chichester: John Wiley & Sons. (Database: ProQuest).
- Hans, R. T. (2013). Work breakdown structure: A tool for software project scope verification. Pretoria: Tshwane University of Technology. (Database: EBSCO).

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Project: Technical Project Planning

**Course Code: DLMDSETPL01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMBITPAM01 |

**Course Description**

The focus of this course is to apply the project management knowledge gained previously in a practical portfolio project and reflect on the results. Students engage in this portfolio project and document the results, reflecting on the project management concepts they apply and the influence of these concepts on the success of the project.

**Course Outcomes**

On successful completion, students will be able to

- apply the concepts of project management to real-world tasks and problems.
- translate the learned theories into the practice of project management.
- analyze a real-world problem and define and implement a project to resolve it.
- appraise the results of a project performed and identify what worked well and what did not.
- explain the work they perform, give its scientific background, and produce adequate documentation.

**Contents**

- In this course, students perform and document a portfolio project in which they apply the project management topics covered in previous modules.

**Literature**

**Compulsory Reading**

**Further Reading**


- Hinde, D. (2012). PRINCE2 Study Guide. West Sussex: John Wiley & Sons.
- Kneuper, R. (2018). Software processes and lifecycle models. Cham: Springer Nature Switzerland.
- Phillips, J. (2010). IT project management: On track from start to finish (3rd ed.). New York, NY: McGraw-Hill.
- Project Management Institute. (2013). A guide to the project management body of knowledge: PMBOK guide.
- Schwaber, K. (2004). Agile project management with Scrum. Redmond, WA: Microsoft Press.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** yes |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☐ Course Book
- ☐ Vodcast
- ☐ Shortcast
- ☐ Audio
- ☐ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☑ Guideline
- ☑ Live Tutorium/Course Feed

DLMDSETPL01

# Data Engineer

**Module Code: DLMDSEDE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Christian Müller-Kett (Data Engineering) / Prof. Dr. Christian Müller-Kett (Project: Data Engineering)

**Contributing Courses to Module**

- Data Engineering (DLMDSEDE01)
- Project: Data Engineering (DLMDSEDE02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Data Engineering<br>• Study Format "Distance Learning": Oral Assignment<br>Project: Data Engineering<br>• Study Format "Fernstudium": Portfolio |

**Weight of Module**

see curriculum

**Module Contents**

**Data Engineering**

- Principles of data engineering
- Paradigms for data processing at scale
- Overview on data governance, security, and protection
- Common cloud platforms
- DataOps approach

**Project: Data Engineering**

- Knowledge transfer and application to practical problems
- Implementation of a data infrastructure building block

**Learning Outcomes**

**Data Engineering**

On successful completion, students will be able to

- understand the foundational concepts in data engineering.
- categorize important data-processing classes.
- summarize common approaches to data governance and security.
- compare different common public cloud offerings.
- recognize current approaches to data operations (DataOps).

**Project: Data Engineering**

On successful completion, students will be able to

- apply the principles of data engineering to a practical application.
- analyze data engineering approaches with respect to a given project task.
- reason about the benefits and drawbacks of solution alternatives for a given implementation task.
- make apposite architectural choices.
- implement aspects of a modern data pipeline

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field of Data Science & Artificial Intelligence. | All Master Programmes in the IT & Technology field. |

# Data Engineering

**Course Code: DLMDSEDE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The focus of this first course in the Data Engineering elective module is to introduce students to important principles, concepts, methods and approaches in this subject domain. In order to achieve this goal, the course moves from an exposition of the foundational principles of data engineering to a thorough treatment of the core data processing classes. Modern architectural paradigms such as Microservices are explained, and important factors in data governance and protection are addressed. Aspects of cloud computing are introduced via an overview of the most common offerings on the market. Finally, a state-of-the-art agile perspective on the operation of data pipelines is given by an exposition to the emerging notion of DataOps.

**Course Outcomes**

On successful completion, students will be able to

- understand the foundational concepts in data engineering.
- categorize important data-processing classes.
- summarize common approaches to data governance and security.
- compare different common public cloud offerings.
- recognize current approaches to data operations (DataOps).

**Contents**

1. Foundations of Data Systems
   - 1.1 Reliability
   - 1.2 Scalability
   - 1.3 Maintainability
2. Data Processing at Scale
   - 2.1 Batch Processing
   - 2.2 Stream and Complex Event Processing
3. Microservices
   - 3.1 Introduction to Microservices
   - 3.2 Implementing Microservices

4. Governance & Security
   - 4.1 Data Protection
   - 4.2 Data Security
   - 4.3 Data Governance

5. Common Cloud Platforms & Services
   - 5.1 Amazon AWS
   - 5.2 Google Cloud
   - 5.3 Microsoft Azure

6. Data Ops
   - 6.1 Defining Principles
   - 6.2 Containerization
   - 6.3 Building Data Pipelines

**Literature**

**Compulsory Reading**

**Further Reading**


- Kleppmann, M. (2017). Designing data intensive applications: The big ideas behind reliable, scalable, and maintainable systems. Sebastopol, CA: O'Reilly.
- Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. Scotts Valley, CA: CreateSpace Independent Publishing Platform.
- White, T. (2015). Hadoop: The definitive guide: Storage and analysis at Internet scale. Sebastopol, CA: O'Reilley.
- Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). Learning Spark: Lightning fast data analysis. Sebastopol, CA: O'Reilley.
- Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide: Real-time data and stream processing at scale. Sebastopol, CA: O'Reilley.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Project: Data Engineering

**Course Code: DLMDSEDE02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSEDE01 |

**Course Description**

The second course of the Data Engineering elective module builds upon theoretical and methodological insights from the first course. It provides opportunities for students to put their newly-acquired knowledge into practical application by completing a data engineering project.In order to find an appropriate and viable approach, students will have to reason about and evaluate the benefits and drawbacks of possible architectural choices. Once an informed decision has been met, the chosen approach is implemented as a running piece of data infrastructure.

**Course Outcomes**

On successful completion, students will be able to

- apply the principles of data engineering to a practical application.
- analyze data engineering approaches with respect to a given project task.
- reason about the benefits and drawbacks of solution alternatives for a given implementation task.
- make apposite architectural choices.
- implement aspects of a modern data pipeline

**Contents**

- The second course of the Data Engineering elective revolves around the implementation of a data engineering project chosen from a set of project suggestions. Students can also contribute their own project ideas.

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Kleppmann, M. (2017). Designing data intensive applications: The big ideas behind reliable, scalable, and maintainable systems. Sebastopol, CA: O'Reilly.<br>▪ Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. Scotts Valley, CA: CreateSpace Independent Publishing Platform.<br>▪ White, T. (2015). Hadoop: The definitive guide: Storage and analysis at Internet scale. Sebastopol, CA: O'Reilley.<br>▪ Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). Learning Spark: Lightning fast data analysis. Sebastopol, CA: O'Reilley.<br>▪ Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide: Real-time data and stream processing at scale. Sebastopol, CA: O'Reilley. |

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☑ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# Business Analyst

**Module Code: DLMDSEBA**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | ▪ DLMDSEBA01<br>▪ none | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Peter Poensgen (Business Intelligence I) / Prof. Dr. Peter Poensgen (Project: Business Intelligence)

**Contributing Courses to Module**

- Business Intelligence I (DLMDSEBA01)
- Project: Business Intelligence (DLMDSEBA02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Business Intelligence I<br>• Study Format "Distance Learning": Written Assessment: Case Study<br>Project: Business Intelligence<br>• Study Format "Distance Learning": Portfolio |

**Weight of Module**

see curriculum

**Module Contents**

**Business Intelligence I**

- Data acquisition and dissemination
- Data warehouse and multidimensional modeling
- Analytical systems

**Project: Business Intelligence**

Implementation of a business intelligence use case.

**Learning Outcomes**

**Business Intelligence I**

On successful completion, students will be able to

- understand the motivations and use cases for, as well as fundamentals of, business intelligence.
- explain relevant types of data.
- know and disambiguate techniques and methods for modeling and dissemination of data.
- expound upon the techniques and methods for the generation and storage of information.select apposite business intelligence methods for given requirements.

**Project: Business Intelligence**

On successful completion, students will be able to

- transfer knowledge of business intelligence methodology to real-world use cases.
- analyze the suitability of different approaches with respect to the project task.
- critically reason about relevant design choices.
- make apposite architectural choices.
- formulate and implement a business intelligence use case.

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
|---|---|
| This module is similar to other modules in the fields of Computer Science & Software Development and Data Science & Artificial Intelligence | All Master Programs in the IT & Technology fields |

# Business Intelligence I

**Course Code: DLMDSEBA01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Business Intelligence is about the generation of information based on operational data. It is used to enable goal-oriented management practices as well as the optimization of relevant business activities. This course introduces and discusses techniques, methods, and models for data provisioning and the generation, analysis, and dissemination of information.

**Course Outcomes**

On successful completion, students will be able to

- understand the motivations and use cases for, as well as fundamentals of, business intelligence.
- explain relevant types of data.
- know and disambiguate techniques and methods for modeling and dissemination of data.
- expound upon the techniques and methods for the generation and storage of information.select apposite business intelligence methods for given requirements.

**Contents**

1. Motivation and Introduction
   - 1.1 Motivation and historical development of the field
   - 1.2 Business intelligence as a framework
2. Data Provisioning
   - 2.1 Operative and dispositive systems
   - 2.2 The data warehouse concept
   - 2.3 Architecture variants
3. Data Warehouse
   - 3.1 The ETL-Process
   - 3.2 DWH and Data-Mart concepts
   - 3.3 ODS and meta-data

4. Modeling Multidimensional Dataspaces
   - 4.1 Data modeling
   - 4.2 OLAP-Cubes
   - 4.3 Physical storage concepts
   - 4.4 Star-Schema and Snowflake-Schema
   - 4.5 Historization

5. Analytical Systems
   - 5.1 Freeform data analysis and OLAP
   - 5.2 Reporting systems
   - 5.3 Model-based analytical systems
   - 5.4 Concept-oriented systems

6. Distribution and Access
   - 6.1 Information distribution
   - 6.2 Information access

**Literature**

**Compulsory Reading**

**Further Reading**


- Kimball, R. (2013). The data warehouse toolkit: The definitive guide to dimensional modeling (3rd ed.). Indianapolis, IN: Wiley.
- Linstedt, D., & Olschimke, M. (2015). Building a scalable data warehouse with Data Vault 2.0. Waltham, MA: Morgan Kaufmann.
- Provost, F. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. Sebastopol, CA: O'Reilly.
- Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Waltham, MA: Morgan Kaufmann.
- Turban, E., Sharda, R., Delen, D., & King, D. (2010). Business intelligence. A managerial approach (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Case Study |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Project: Business Intelligence

**Course Code: DLMDSEBA02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSEBA01 |

**Course Description**

In this course the students will transfer knowledge of business intelligence approaches and methods to the implementation of a real-world business analytical use case. To accomplish this goal, students must look closely at the given task and find an apposite approach by analyzing, evaluating, and comparing different solution strategies and their constituent parts. The found solution then has to be implemented in order to arrive at a running business analytical system.

**Course Outcomes**

On successful completion, students will be able to

- transfer knowledge of business intelligence methodology to real-world use cases.
- analyze the suitability of different approaches with respect to the project task.
- critically reason about relevant design choices.
- make apposite architectural choices.
- formulate and implement a business intelligence use case.

**Contents**

- This second course in the Business Analyst specialization aims at the practical implementation of a business intelligence project. Students can choose from a list of project topics or contribute their own ideas.

**Literature**

**Compulsory Reading**

**Further Reading**


- Kimball, R. (2013). The data warehouse toolkit: The definitive guide to dimensional modeling (3rd ed.). Indianapolis, IN: Wiley.
- Linstedt, D., & Olschimke, M. (2015). Building a scalable data warehouse with Data Vault 2.0. Waltham, MA: Morgan Kaufmann.
- Provost, F. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. Sebastopol, CA: O'Reilly.
- Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Waltham, MA: Morgan Kaufmann.
- Turban, E., Sharda, R., Delen, D., & King, D. (2010). Business intelligence. A managerial approach (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☑ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# 3. Semester

# Cyber Security and Data Protection

**Module Code: DLMCSITSDP**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ralf Kneuper (Cyber Security and Data Protection)

**Contributing Courses to Module**

- Cyber Security and Data Protection (DLMCSITSDP01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Data protection and privacy
- Cyber security building blocks
- Cyber security management
- Cryptography concepts
- Cryptography applications

**Learning Outcomes**

**Cyber Security and Data Protection**

On successful completion, students will be able to

- explain the core concepts of cyber security, data protection, and cryptography including their differences and relationships.
- compare the approaches to data protection within in different legal systems.
- apply data protection concepts to data science and other application scenarios.
- analyze application scenarios to identify the adequate cyber security management measures that should be implemented.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field of Computer Science & Software Development. | All Master Programmes in the IT & Technology field. |

# Cyber Security and Data Protection

**Course Code: DLMCSITSDP01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

With the increasing digitization and networking of IT systems, the need for safeguarding systems and the data processed by these systems has grown. The aim of this module is to provide an understanding of security measures needed, cyber security including cryptography, and data protection. While the need for cyber security is similar around the world, different cultures have different expectations regarding data protection and privacy. Nevertheless, personal data are often processed outside the country where the affected individuals live. Hence, the cultural aspects of data protection need to be taken into account wherever the data are processed. This course provides an overview of the main cyber security measures in different application scenarios, as well as their integration into an Information Security Management System, with particular focus on the relevant ISO/IEC 270xx family of standards. Cryptography provides an important tool set for cyber security and is used in many different application scenarios such as secure Internet protocols and block chain.

**Course Outcomes**

On successful completion, students will be able to

- explain the core concepts of cyber security, data protection, and cryptography including their differences and relationships.
- compare the approaches to data protection within in different legal systems.
- apply data protection concepts to data science and other application scenarios.
- analyze application scenarios to identify the adequate cyber security management measures that should be implemented.

**Contents**

1. Foundations of Data Protection and Cyber Security
   - 1.1 Terminology and Risk Management
   - 1.2 Core Concepts of Cyber Security
   - 1.3 Core Concepts of Data Protection and Privacy
   - 1.4 Core Concepts of Cryptography
   - 1.5 Legal Aspects

2. Data Protection
   - 2.1 Basic Concepts of Data Protection (ISO/IEC 29100, Privacy by Design)
   - 2.2 Data Protection in Europe: the GDPR
   - 2.3 Data Protection in the USA
   - 2.4 Data Protection in Asia

3. Applying Data Protection
   - 3.1 Anonymity and Pseudonyms (k-Anonymity, i-Diversity, Differential Privacy)
   - 3.2 Data Protection in Data Science and Big Data
   - 3.3 User Tracking in Online Marketing
   - 3.4 Cloud Computing

4. Building Blocks of Cyber Security
   - 4.1 Authentication, Access Management and Control
   - 4.2 Cyber Security in Networks
   - 4.3 Developing Secure IT Systems (OWASP, etc.)

5. Cyber Security Management
   - 5.1 Security Policy
   - 5.2 Security and Risk Analysis
   - 5.3 The ISO 270xx Series
   - 5.4 IT Security and IT Governance
   - 5.5 Example: Cyber Security for Credit Cards (PCI DSS)

6. Cryptography
   - 6.1 Symmetric Cryptography
   - 6.2 Asymmetric Cryptography
   - 6.3 Hash Functions
   - 6.4 Secure Data Exchange (Diffie-Hellman, Perfect Forward Secrecy, etc.)

7. Cryptographic Applications
   - 7.1 Digital Signatures
   - 7.2 Electronic Money
   - 7.3 Secure Internet Protocols (TLS, IPSec, etc.)
   - 7.4 Block Chain

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Bowman, C., Gesher, A., Grant, J., & Slate, D. (2015). The architecture of privacy: On engineering technologies that can deliver trustworthy safeguards. Sebastopol, CA: O'Reilly.<br>▪ Hintzbergen, J., Hintzbergen, K., Smulders, A., & Baars, H. (2015). Foundations of information security (3rd ed.). Zaltbommel: Van Haren Publishing.<br>▪ ISO/IEC 29100. (2011). Information technology — Security techniques — Privacy framework. ISO. Retrieved from https://standards.iso.org/ittf/PubliclyAvailableStandards/c045123_ISO_IEC_29100_2011.zip<br>▪ Paar, C., & Pelzl, J. (2011). Understanding cryptography: A textbook for students and practitioners. Heidelberg: Springer.<br>▪ The Open Web Application Security Project (OWASP). (2005). A guide to building secure web applications and web services. OWASP. Retrieved from https://www.um.es/atica/documentos/OWASPGuide2.0.1.pdf |

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☐ Vodcast
- ☑ Shortcast
- ☑ Audio
- ☐ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☑ Guideline
- ☑ Live Tutorium/Course Feed

# Case Study: Model Engineering

**Module Code: DLMDSME**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLMDSAM, DLMDSAS, DLMDSPWP, DLMDSML, DLMDSDL | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Markus Pak (Case Study: Model Engineering)

**Contributing Courses to Module**

- Case Study: Model Engineering (DLMDSME01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Case Study | |

**Weight of Module**

see curriculum

**Module Contents**

- Data science methodologies
- Data quality
- Feature engineering
- Feature selection
- Building a predictive model
- Avoiding common fallacies

**Learning Outcomes**

**Case Study: Model Engineering**

On successful completion, students will be able to

- understand current data science methodologies.
- devaluate the quality of the data used in data science projects.
- create new features from raw data.
- apply feature selection techniques.
- make predictive models using data science techniques.
- identify common fallacies and know how to avoid them.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Case Study: Model Engineering

**Course Code: DLMDSME01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM, DLMDSAS, DLMDSPWP, DLMDSML, DLMDSDL |

**Course Description**

The construction of data science models and applying the techniques to real-world problems requires a deep understanding of data science processes and techniques beyond the application of relevant algorithms.This course starts by introducing two commonly used data science methodologies: CRISP-DM and MS Team Data Science. Any data taken from real machines, systems, or processes will include some errors to varying degrees. This course discusses in detail how to detect and correct data quality issues, including the importance of domain knowledge in the determination of the veracity of the data.Many machine learning approaches require the creation and subsequent selection of model features which determine which part of the data are used in which way in the later modelling step. This course discusses methods to engineer and build new features from raw data and outlines statistical methods to identify the most relevant features for the given task.Finally, this course outlines strategies to avoid common fallacies when building data science models, as well as approaches to automate workflows.

**Course Outcomes**

On successful completion, students will be able to

- understand current data science methodologies.
- devaluate the quality of the data used in data science projects.
- create new features from raw data.
- apply feature selection techniques.
- make predictive models using data science techniques.
- identify common fallacies and know how to avoid them.

**Contents**

1. Data Science Methodologies
   - 1.1 CRISP-DM
   - 1.2 MS Team Data Science
2. Data Quality
   - 2.1 Evaluating data quality
   - 2.2 Using low quality data
   - 2.3 Data duality and domain knowledge

3. Feature Engineering
   - 3.1 Building new features
   - 3.2 Splitting variables
   - 3.3 Feature engineering exploiting domain knowledge

4. Feature Selection
   - 4.1 Univariate feature selection
   - 4.2 Model based feature selection

5. Building a Predictive Model
   - 5.1 Establishing a benchmark model
   - 5.2 Prediction as probabilities
   - 5.3 Interpretable machine learning and results

6. Avoiding Common Fallacies
   - 6.1 Overtraining & generalization
   - 6.2 Overfitting & Occam's Razor
   - 6.3 Workflow automation and model persistence

**Literature**

**Compulsory Reading**

**Further Reading**


- Chapman, P. (n.d.). CRISP-DM user guide [PDF document]. Retrieved from https://s2.smu.edu/~mhd/8331f03/crisp.pdf
- Geron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow. Boston, MA: O'Reilly Publishing.
- Kuhn, M., & Johnson, K. (2013). Applied predictive modeling. New York, NY: Springer.
- Maydanchik, A. (2007). Data quality assessment. New Jersey: Technics Publications.
- Microsoft. (2017). Team Data Science Process Documentation. Retrieved from https://docs.microsoft.com/en-us/azure/machine-learning/team-data-science-process/overview
- Müller, A., & Guido, S. (2016). Introduction to machine learning with Python: A guide for data scientists. Boston, MA: O'Reilly.
- Olson, J. (2003). Data quality – The accuracy dimension. San Francisco, CA: Morgan Kaufmann.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Case Study |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Software Engineering for Data Intensive Sciences

**Module Code: DLMDSSEDIS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLMDSPWP | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Max Pumperla (Software Engineering for Data Intensive Sciences)

**Contributing Courses to Module**

- Software Engineering for Data Intensive Sciences (DLMDSSEDIS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Agile project management
- DevOps
- Software development
- API
- From model to production

**Learning Outcomes**

**Software Engineering for Data Intensive Sciences**

On successful completion, students will be able to

- understand the agile approaches Scrum and Kanban.
- explain how DevOps brings software development and operations together into one team.
- write high-quality code using relevant software development techniques.
- evaluate the requirements for APIs.
- create APIs for software applications.
- identify the challenges of bringing a model into production.

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Software Engineering for Data Intensive Sciences

**Course Code: DLMDSSEDIS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSPWP |

**Course Description**

Building a successful data-based product requires a significant amount of high-quality code which needs to run in a professional production environment. This course starts by introducing the agile approaches Scrum and Kanban and then discusses the shift from more traditional software development approaches to the DevOps culture.Special focus is given to the discussion and understanding of techniques and approaches for producing high-quality code such as unit and integration testing, test-driven development, pair programing, and continuous delivery and integration.Since many software artefacts are accessed via APIs, this course introduces concepts of API design and paradigms.Finally, this course addresses the challenges of bringing code into a production environment, building a scalable environment, and using cloud-cased approaches.

**Course Outcomes**

On successful completion, students will be able to

- understand the agile approaches Scrum and Kanban.
- explain how DevOps brings software development and operations together into one team.
- write high-quality code using relevant software development techniques.
- evaluate the requirements for APIs.
- create APIs for software applications.
- identify the challenges of bringing a model into production.

**Contents**

1. Agile Project Management
   - 1.1 Introduction to SCRUM
   - 1.2 Introduction to Kanban
2. DevOps
   - 2.1 Traditional lifecycle management
   - 2.2 Bringing development and operations together
   - 2.3 Impact of team structure
   - 2.4 Building a DevOps infrastructure

3. Software Development
   - 3.1 Unit & integration test, performance monitoring
   - 3.2 Test-driven development & pair programing
   - 3.3 Continuous delivery & integration
   - 3.4 Overview of relevant tools

4. API
   - 4.1 API design
   - 4.2 API paradigms

5. From Model to Production
   - 5.1 Building a scalable environment
   - 5.2 Model versioning and persistence
   - 5.3 Cloud-based approaches

**Literature**

**Compulsory Reading**

**Further Reading**


- Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices . Scotts Valley, CA: CreateSpace Independent Publishing Platform.
- Humble, J., & Farley, D. (2010). Continuous delivery: Reliable software releases through build, test, and deployment automation . Boston, MA: Addison-Wesley Professional.
- Humble, J., Molesky, J., & O'Reilly, B. (2015). Lean enterprise . Sebastopol, CA: O'Reilley Publishing.
- Hunt, A., & Thomas, D. (1999). The pragmatic programmer. From journeyman to master. Reading, MA: Addison-Wesley.
- Martin, R. C. (2008). Clean code . Boston, MA: Prentice Hall.
- Morris, K. (2016). Infrastructure as code . Sebastopol, CA: O'Reilley Publishing.
- Richardson, L., & Ruby, S. (2007). RESTful web services. Sebastopol, CA: O'Reilley Publishing.
- Senge, P. (1990). The fifth discipline: The art and practice of the learning organization. New York, NY: Broadway Business.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☑ Vodcast
- ☑ Shortcast
- ☐ Audio
- ☐ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☑ Guideline
- ☐ Live Tutorium/Course Feed

DLMDSSEDIS01

# Management

**Module Code: DLMMANE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MBA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Georg Berkel (Leadership) / Prof. Maren Weber (Strategic Management)

**Contributing Courses to Module**

- Leadership (DLMBLSE01)
- Strategic Management (DLMBSME01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Leadership<br>• Study Format "Fernstudium": Exam, 90 Minutes<br>Strategic Management<br>• Study Format "Distance Learning": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**Leadership**

- Foundations and concepts of strategic management
- Strategic planning process
- International challenges of strategic management

**Strategic Management**

- Foundations of professional leadership
- Leadership and motivation in the corporation
- Leadership and corporate culture
- Leadership and change management

**Learning Outcomes**

**Leadership**

On successful completion, students will be able to

- Recognize underlying beliefs and attitudes towards leadership and compare the influence of various theories of leadership on the identification and development of leaders.
- Outline the influence of social roles on leaders and employees, and assess the influence of roles types on the interactions between leaders and those they are leading.
- As a leader, support employees by drawing on empirical evidence to effectively meet the expectations of employees.
- Recognize the roles and conflicting interests inherent to leadership positions and develop strategies to address locomotion and cohesion.
- Discriminate between effective and non-effective methods for managing staff and organizational activities, and apply those techniques and tools in practice to maximize the satisfaction and effectiveness of staff.
- Perform the various responsibilities delegated to a leader such as communicate with employees, lead planning activities, delegate tasks, and plan and lead controlling activities.
- Create a plan to support employees through the process of change within an organization.
- Assess personal leadership style using a variety of measures and evaluate leadership activities relative to transactional and transformational leadership styles.

**Strategic Management**

On successful completion, students will be able to

- Understand the entire process of strategic planning from the organizational planning, the implementation to the evaluation and controlling.
- Apply appropriate analysis tools in order to methodically address specific business decisions.
- Analyze the capabilities of their organization from a functional and resource perspective by evaluating its strengths and weaknesses.
- Develop a better understanding of the wider business environment by analyzing the opportunities and threats facing their organization.
- Evaluate strategies by employing appropriate controlling tools.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Business Administration & Management | All Master Programmes in the Business & Management fields |

# Leadership

**Course Code: DLMBLSE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MBA | English | | 5 | None |

**Course Description**

In today's knowledge-based society, employees are a firm's most valuable resource. A key responsibility of leadership is to develop the knowledge, expertise, and skills of employees. Good leadership is crucial for the continued success of a firm in the face of increasingly competitive markets. This course presents the necessary competencies of the leader in a modern, knowledge-based organization. Central questions raised by modern leadership theory are presented and discussed. In doing so, the course focuses on requirements and instruments of professional leadership, aspects of situational leadership, and leadership communication and interactions, both in the context of strategic management and change processes. The methodological and conceptual foundations of leadership are presented to students, along with empirical examples and best-practice principles, with the intent for students to master the challenges of enhancing the firm's most valuable asset—its employees—via professional and contemporary leadership practices.

**Course Outcomes**

On successful completion, students will be able to

- Recognize underlying beliefs and attitudes towards leadership and compare the influence of various theories of leadership on the identification and development of leaders.
- Outline the influence of social roles on leaders and employees, and assess the influence of roles types on the interactions between leaders and those they are leading.
- As a leader, support employees by drawing on empirical evidence to effectively meet the expectations of employees.
- Recognize the roles and conflicting interests inherent to leadership positions and develop strategies to address locomotion and cohesion.
- Discriminate between effective and non-effective methods for managing staff and organizational activities, and apply those techniques and tools in practice to maximize the satisfaction and effectiveness of staff.
- Perform the various responsibilities delegated to a leader such as communicate with employees, lead planning activities, delegate tasks, and plan and lead controlling activities.
- Create a plan to support employees through the process of change within an organization.
- Assess personal leadership style using a variety of measures and evaluate leadership activities relative to transactional and transformational leadership styles.

**Contents**

1. An Overview of Leadership
   - 1.1 Leadership and Personality: Trait Theories
   - 1.2 Leadership as a Skill: Attribute and Behavior Theories
   - 1.3 Positive Reinforcement: Behavioral Theories
   - 1.4 Leadership Dependent on the Situation: Situational Approaches
   - 1.5 Situational and Contingency Theories
   - 1.6 Theory of Functional Leadership Behavior
   - 1.7 Integrated Psychological Theory
   - 1.8 Transactional and Transformative Leadership
   - 1.9 Leadership as an Emotionally Charged Process
   - 1.10 Neo-Emergent Theory

2. Leadership as a Social Role
   - 2.1 Roles and Groups
   - 2.2 Role Types
   - 2.3 Formal Conditions for Social Roles – Corporate Context Determining Roles in Organizations
   - 2.4 The Individual and The Group – Conforming and Deviating Behavior
   - 2.5 The Problems of Formalized Role Understanding and Self-Concept

3. Leadership from the Employee's Perspective
   - 3.1 General Expectations for Managers
   - 3.2 Truthfulness and Authenticity
   - 3.3 Handling Conflicts Competently
   - 3.4 Conflicts in Groups
   - 3.5 Conflict Resolution Pattern According to Matzat
   - 3.6 Enthusiasm
   - 3.7 Ability to Cope with Pressure
   - 3.8 Assertiveness
   - 3.9 Empathy
   - 3.10 Expertise

4. Leadership from the Manager's Perspective
   - 4.1 Self-Concept as a Manager
   - 4.2 Locomotion and Cohesion
   - 4.3 Individual Problems and Learning Dimensions of Management Behavior
   - 4.4 The Concept of Human Nature and Its Influence on Management Behavior: Theories from Maslow, McGregor, and Herzberg
   - 4.5 Ambiguity Tolerance

5. Management Tools
   - 5.1 Management Tools - Definition
   - 5.2 Organizational Management Tools
   - 5.3 Personnel Management Tools

6. Managerial Functions
   - 6.1 Responsibilities of a Manager
   - 6.2 Communication
   - 6.3 Foundations of Interpersonal Communication
   - 6.4 Planning
   - 6.5 Setting Objectives
   - 6.6 Delegating
   - 6.7 Controlling
   - 6.8 Creating a Feedback Culture

7. Organizational Change
   - 7.1 Knowledge
   - 7.2 Cultural Value Change and Subjectification
   - 7.3 Globalization
   - 7.4 Technological Progress
   - 7.5 Change Management – Leadership in Times of Change

8. Successful Employee Management
   - 8.1 Measuring Leadership Style and Leadership Behavior
   - 8.2 Measuring Transactional and Transformational Leadership with the Multifactor Leadership Questionnaire (MLQ)
   - 8.3 Correlation of Leadership Behavior with Subjective and Objective Success Criteria
   - 8.4 Validation of Leadership Success Using Situational Factors
   - 8.5 Leadership Principles Guiding Leadership Behavior

**Literature**

**Compulsory Reading**

**Further Reading**


- Gneezy, U., & Rustichini, A. (2000). Pay enough or don't pay at all. The Quarterly Journal of Economics,115(3), 791–810. (Database: EBSCO).
- Goleman, D., Boyatzis, R., & McKee, A. (2004). Primal leadership: Learning to lead with emotionalintelligence. Boston, MA: Harvard Business School Press.
- Hechter, M., & Opp, K.-D. (2001). Social norms. New York, NY: Russell Sage Foundation.
- Herzberg, F., Mausner, B., & Bloch Synderman, B. (1993). The motivation to work. New Brunswick:Transaction Publishers. (Database: EBSCO).
- Kouzes, J. M., & Posner, B. Z. (1999). Encouraging the heart: A leader's guide to rewarding and recognizingothers. San Francisco, CA: Jossey-Bass. (Database: CIANDO).
- Maslow, A. (1954). Motivation and personality. New York, NY: Harper & Row.
- Norton, R. W. (1975). Measurement of ambiguity tolerance. Journal of Personality Assessment, 39(6), 607–619. (Database: EBSCO).
- Trilling, L. (1972). Sincerity and authenticity. Cambridge, MA: Harvard University Press. (Database: EBSCO).

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☑ Vodcast | ☐ Guideline |
| ☐ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Strategic Management

**Course Code: DLMBSME01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MBA | English | | 5 | None |

**Course Description**

Various methods of strategic market analysis are presented in this course so as to allow students to evaluate risks and opportunities in markets and understand strengths and weaknesses of organizations that face specific market situations. Supported by new developments in the field of market research, the process for identifying and analyzing core competencies and competitive advantages in national and international environments is discussed at length. Students are supported to plan strategic alternatives and to implement and control these by taking on fictitious roles within the organization. Exercises and case studies help students to identify with the role of management and participate in the strategic planning process as well as in operational management. This helps students understand the problems companies regularly face and comprehend how methods of modern management can be used in order to solve these.

**Course Outcomes**

On successful completion, students will be able to

- Understand the entire process of strategic planning from the organizational planning, the implementation to the evaluation and controlling.
- Apply appropriate analysis tools in order to methodically address specific business decisions.
- Analyze the capabilities of their organization from a functional and resource perspective by evaluating its strengths and weaknesses.
- Develop a better understanding of the wider business environment by analyzing the opportunities and threats facing their organization.
- Evaluate strategies by employing appropriate controlling tools.

**Contents**

1. What is Strategy?
   - 1.1 What is a Corporate Strategy?
   - 1.2 What Has to be Taken into Consideration when Making Strategic Decisions?
   - 1.3 Who Takes Part in Developing a Strategy?
   - 1.4 What is Included in a Solid Strategic Plan?

2. The Strategic Environment
   - 2.1 Where Are We in the Market Place? The Macro Environment
   - 2.2 Where Are We in the Market Place? The Micro Environment
   - 2.3 Analysis, Strategic Capabilities, and the Five Forces Model

3. The Position in the Market
   - 3.1 Why Do We Exist?
   - 3.2 What is Our Position in the Market?
   - 3.3 What Information Does the Company Need?
   - 3.4 What Capabilities Does the Company Have?
   - 3.5 What Capabilities Do Others Have?

4. What Strategic Options Are Available to the Strategic Business Unit (SBU)?
   - 4.1 What Strategic Options Does the SBU Have?
   - 4.2 Interactive Strategies
   - 4.3 Product Life Cycle

5. What Strategic Options Are Available to the Corporation?
   - 5.1 Areas to Consider When Formulating a Strategy
   - 5.2 Strategic Options
   - 5.3 Outsourcing
   - 5.4 Product Portfolio Analysis Using the BCG Matrix
   - 5.5 Product Portfolio Analysis Using the GE-McKinsey Matrix

6. What International Strategies Are Available?
   - 6.1 Why Do Companies Go International?
   - 6.2 What Factors Contribute to the Decision About Which Country to Invest In?
   - 6.3 How Can a Company Invest Internationally?

7. Do-It-Yourself, Buy, or Ally?
   - 7.1 Do-It-Yourself
   - 7.2 Mergers and Acquisitions (M&As)
   - 7.3 Strategic Alliances
   - 7.4 How to Decide Whether to Buy, Alley, or Do-It-Yourself?

8. How to Evaluate Strategies?
   - 8.1 How to Evaluate Strategy?
   - 8.2 Implementing Strategy

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Hooley, G. J., Piercy, N., Nicoulaud, B., & Rudd, J. M. (2017). Marketing strategy and competitive positioning(6th ed.). Harlow: Pearson Education.<br>▪ Johnson, G., Whittington, R., Scholes, K., Angwin, D., & Regnér, P. (2017). Exploring strategy: Text and cases(10th ed.). Harlow: Pearson Education.<br>▪ Kotler, P. T., & Keller, K. L. (2015). Marketing management (15th ed.). Harlow: Pearson.<br>▪ Porter, M. (2004). Competitive strategy: Techniques for analyzing industries and competitors. New York, NY:Free Press.<br>▪ Porter, M. (2008). On competition (2nd ed.). Boston: Harvard Business Review Press. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Sales, Pricing and Brand Management

**Module Code: DLMBSPBE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Caterina Fox (Global Brand Management) / Caterina Fox (Sales and Pricing)

**Contributing Courses to Module**

- Global Brand Management (DLMBSPBE01)
- Sales and Pricing (DLMBSPBE02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Global Brand Management<br>• Study Format "Fernstudium": Exam, 90 Minutes<br>Sales and Pricing<br>• Study Format "Fernstudium": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**Global Brand Management**

- For most companies, a major opportunity to grow their business involves looking for possibilities outside their native country. However, taking brands beyond national boundaries presents a new set of branding issues as the global marketplace is constantly changing. At the same time, various forms of regionalization are taking place, adding another layer of complexity to managing a brand portfolio. Arguably, products, pricing and distribution are increasingly becoming commodities and the new competitive arena is brand value, creating long-term, profitable brand relationships. Ultimately, strong brands will transcend industries and provide an organization with one of its most valuable assets. This course ultimately aims to introduce students to the differentiation of products and services in a world of alternatives and the benefits/disadvantages of providing customers with the power of choice.

Establishing and maintaining a competitive customer interface is one of the major challenges for every company to assure successful revenue- and profit-management. The course will allow students to understanding the optimization levers of the customer interface. This includes advanced methods of market- and customer segmentation, channel management including the design, setup and optimization of a customer oriented sales organization (e.g. key account management), practices for sales-force-effectiveness, sales optimization levers, e.g. for customer penetration, and methods for price-differentiation and -realization. The course incorporates case-studies and practice related data and for each optimization lever, students are introduced to a comprehensive tool-box approach. The tool box for each lever contains the required theory, a set of basic analyses and the application of best-practice examples and metrics.

**Sales and Pricing**

**Learning Outcomes**

**Global Brand Management**

On successful completion, students will be able to

- analyze brands, brand components and brand management.
- examine how brands are positioned and re-positioned in regional, national and international markets and explore the concept of shared- and co-operative branding.
- promote the importance of brand valuation and measurement techniques within their company.
- form and apply tactics to address brand falsification and protection as well as to develop strategies to manage a brand crisis.
- analyze the main challenges facing international brands, and be able to measure their brand equity
- understand the factors that contribute to increasing or losing consumer-based brand equity.
- analyze a company's current brand strategy and propose viable alternatives as well as make informed decisions with greater probability of success.

**Sales and Pricing**

On successful completion, students will be able to

- identify the key-success factors for modern sales organizations.
- describe the relationship between segmentation and the design of an appropriate sales organization.
- execute respective analyses and apply improvement levers.
- demonstrate the use of the tool-boxes for the respective optimization levers.
- identify major characteristics of a high-performance sales organization.
- conduct decisive analyses to assess the strength and weaknesses of a sales organization and identify respective optimization levers.
- implement the required organizational and process-related improvement levers.
- measure the performance of a sales-organization using established methods, KPIs and metrics.
- apply fundamental concepts of international pricing.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field(s) of Marketing & Sales | All Master Programmes in the Marketing field(s) |

# Global Brand Management

**Course Code: DLMBSPBE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

For most companies, a major opportunity to grow their business involves looking for possibilities outside their native country. However, taking brands beyond national boundaries presents a new set of branding issues as the global marketplace is constantly changing. At the same time, various forms of regionalization are taking place, adding another layer of complexity to managing a brand portfolio. Arguably, products, pricing and distribution are increasingly becoming commodities and the new competitive arena is brand value, creating long-term, profitable brand relationships. Ultimately, strong brands will transcend industries and provide an organization with one of its most valuable assets. This course ultimately aims to introduce students to the differentiation of products and services in a world of alternatives and the benefits/disadvantages of providing customers with the power of choice.

**Course Outcomes**

On successful completion, students will be able to

- analyze brands, brand components and brand management.
- examine how brands are positioned and re-positioned in regional, national and international markets and explore the concept of shared- and co-operative branding.
- promote the importance of brand valuation and measurement techniques within their company.
- form and apply tactics to address brand falsification and protection as well as to develop strategies to manage a brand crisis.
- analyze the main challenges facing international brands, and be able to measure their brand equity
- understand the factors that contribute to increasing or losing consumer-based brand equity.
- analyze a company's current brand strategy and propose viable alternatives as well as make informed decisions with greater probability of success.

**Contents**

1. Introduction to Global Brand Management
   - 1.1 Brand, Brand Equity, and Brand Value
   - 1.2 Brand Management and Brand Leadership
   - 1.3 Integrating Marketing Activities

2. Culture and Branding
   - 2.1 What is Culture?
   - 2.2 Culture and Consumer Behavior
   - 2.3 The Global-Local Dilemma of Branding

3. Creating Global Brands
   - 3.1 Brand Positioning
   - 3.2 Designing and Implementing Stages of Branding Strategies
   - 3.3 Choosing Brand Elements to Build Brand Equity
   - 3.4 Designing Marketing Programs to Build Brand Equity

4. Managing Global Brands
   - 4.1 Branding Strategy
   - 4.2 Brand Hierarchy
   - 4.3 Business-to-Business (B2B) Brand Management Strategies

5. Growing and Sustaining Brand Equity
   - 5.1 Extending the Brand
   - 5.2 Brand Alliances
   - 5.3 Green and Cause Marketing

6. Measuring Global Brand Equity and Performance
   - 6.1 Brand Equity Measurement Systems
   - 6.2 Measuring Sources of Brand Equity
   - 6.3 Measuring Outcomes of Brand Equity

7. Brand Analysis and Strategy Across Multiple Markets: A Managerial Approach
   - 7.1 Internal Analysis
   - 7.2 External Analysis
   - 7.3 Global Brand Management Scenarios

8. Managing a Brand Crisis
   - 8.1 Revitalizing a Brand
   - 8.2 Brand Falsification
   - 8.3 Brand Protection Strategies
   - 8.4 Brand Crises

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Aaker, D. A. (1991). Managing brand equity. New York, NY: Free Press.<br>▪ de Mooij, M. (2014). Global marketing and advertising: Understanding cultural paradoxes (4th ed.). Thousand Oaks, CA: Sage.<br>▪ Kapferer, J. N. (2012). The new strategic brand management: Advanced insights and strategic thinking (5th ed.). London: Kogan Page.<br>▪ Keller, K. L., Aperia, T., & Georgson, M. (2013). Strategic brand management: A European perspective (2nd ed.). Upper Saddle River, NJ: Prentice Hall. (Database: MyiLibrary). |

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☑ Vodcast | ☐ Guideline |
| ☐ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Sales and Pricing

**Course Code: DLMBSPBE02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMBSPBE01 |

**Course Description**

Establishing and maintaining a competitive customer interface is one of the major challenges for every company to assure successful revenue- and profit-management.The course will allow students to understanding the optimization levers of the customer interface. This includes advanced methods of market- and customer segmentation, channel management including the design, setup and optimization of a customer oriented sales organization (e.g. key account management), practices for sales-force-effectiveness, sales optimization levers, e.g. for customer penetration, and methods for price-differentiation and -realization.The course incorporates case-studies and practice related data and for each optimization lever, students are introduced to a comprehensive tool-box approach. The tool box for each lever contains the required theory, a set of basic analyses and the application of best-practice examples and metrics.

**Course Outcomes**

On successful completion, students will be able to

- identify the key-success factors for modern sales organizations.
- describe the relationship between segmentation and the design of an appropriate sales organization.
- execute respective analyses and apply improvement levers.
- demonstrate the use of the tool-boxes for the respective optimization levers.
- identify major characteristics of a high-performance sales organization.
- conduct decisive analyses to assess the strength and weaknesses of a sales organization and identify respective optimization levers.
- implement the required organizational and process-related improvement levers.
- measure the performance of a sales-organization using established methods, KPIs and metrics.
- apply fundamental concepts of international pricing.

**Contents**

1. Segmentation
   - 1.1 Customer Segmentation
   - 1.2 Selection of Market Segments for Market Entry
   - 1.3 Development of Market Segments

2. Channel Management
   - 2.1 Distribution System as a Function of the Products Sold
   - 2.2 Selection of Distribution Partners
   - 2.3 Professionalization and Mobilization of Distribution Partners
   - 2.4 Control of Distribution Partners

3. Sales Force Effectiveness
   - 3.1 Sales Strategy
   - 3.2 Sales Process
   - 3.3 Sales Organization
   - 3.4 Sales Information and Management Systems
   - 3.5 Sales Controlling

4. Sales Optimization Levers
   - 4.1 Key Account Management
   - 4.2 Proactive Sales
   - 4.3 Value-Based Selling
   - 4.4 Online Sales Tools

5. Fundamentals of International Pricing
   - 5.1 Pricing Strategies
   - 5.2 Pricing for Market Segments
   - 5.3 Transaction Pricing and Managing the Price Waterfall
   - 5.4 Price Differentiation and Standardization in an International Context

6. Special Topics in International Pricing
   - 6.1 Gray Markets
   - 6.2 Transfer Pricing
   - 6.3 Price Wars
   - 6.4 Innovative Pricing Methods
   - 6.5 Risks in International Business

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Dibb, S., & Simkin, L. (2010). The market segmentation workbook: Target marketing for marketing managers. Boston, MA: Cengage Learning.<br>▪ Kotler, P., Keller, K., Brady, M., Goodman, M., & Hansen, T. (2016). Marketing management (3rd ed.) (pp. 331–420). Harlow: Pearson Education. (Database: Myilibrary).<br>▪ Nagle, T. T., Zale, J., & Hogan, J. (2016). The strategy and tactics of pricing (5th ed.). Abingdon: Routledge. (Database: EBSCO).<br>▪ Zoltners, A. A., Sinha, P., & Zoltners, G. A. (2001). The complete guide to accelerating sales force performance: How to get more sales from your sales force. New York, NY: Amacom. (Database: EBSCO). |

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☑ Vodcast | ☐ Guideline |
| ☐ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

DLMBSPBE02

# Consumer Behavior and Research

**Module Code: DLMBCBR**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Caterina Fox (International Consumer Behavior) / Caterina Fox (Applied Marketing Research)

**Contributing Courses to Module**

- International Consumer Behavior (DLMBCBR01)
- Applied Marketing Research (DLMBCBR02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | International Consumer Behavior<br>• Study Format "Distance Learning": Exam, 90 Minutes<br>Applied Marketing Research<br>• Study Format "Distance Learning": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**International Consumer Behavior**

- Consumer Behavior
- The Consumer Decision-Making Process
- Internal Influences on Consumer Behavior
- External Influences on Consumer Behavior
- International Consumer Behavior
- International Marketing Strategy and Consumer Behavior

**Applied Marketing Research**

- The Role of Marketing Research in Managerial Decision-Making
- Problem Definition and the Marketing Research Process
- Secondary Data and Qualitative Research
- Survey Research and the Concept of Measurement
- Observational Research
- Sampling Issues, Data Processing, and Fundamental Data Analysis
- Communicating the Research Results

**Learning Outcomes**

**International Consumer Behavior**

On successful completion, students will be able to

- outline the purchase decision-making process undertaken by the consumer.
- describe the internal and external influences on the consumer decision-making processes.
- identify the different research methods available to companies to collect relevant data regarding their consumers and their behavior
- develop a plan to generate required market research data regarding consumer behavior and decision-making.
- be able to generate, analyze, interpret and report relevant data regarding consumers.
- present the key concepts characterizing international consumer behavior and discuss their impact on global marketing strategies.

**Applied Marketing Research**

On successful completion, students will be able to

- recognize and promote the importance of marketing research methodologies in supporting key marketing management decisions.
- identify some of the challenges of marketing research in an international environment.
- identify appropriate analysis tools for a given marketing related problem on a strategic and operational level.
- identify errors made in the research process.
- Outline the stages of the marketing research process.
- identify ethics problems in a marketing research situation and propose an ethically sound approach.
- propose a research design to study a particular research question.
- compare and contrast different research methods.
- recommend good practice for a variety of research techniques.
- Design questionnaires with sound measurement properties.
- interpret results of advanced marketing research efforts.
- transfer the gained insights into their future international work environment.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field(s) Marketing & Sales | All Master Programmes in the Marketing field(s) |

# International Consumer Behavior

**Course Code: DLMBCBR01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

In a global economy characterized by greater competition, companies operating internationally need comprehensive market-driven strategies to survive in the market place. The course provides students with the relevant concepts for understanding the international environment of the company with focus on the demand side/the consumer. Students learn how differences in culture, economic systems, and political environments impact consumers' behavior in terms of decision-making in the fields of acquisition, consumption, and disposal of products, services, experiences, and ideas.

**Course Outcomes**

On successful completion, students will be able to

- outline the purchase decision-making process undertaken by the consumer.
- describe the internal and external influences on the consumer decision-making processes.
- identify the different research methods available to companies to collect relevant data regarding their consumers and their behavior
- develop a plan to generate required market research data regarding consumer behavior and decision-making.
- be able to generate, analyze, interpret and report relevant data regarding consumers.
- present the key concepts characterizing international consumer behavior and discuss their impact on global marketing strategies.

**Contents**

1. Consumer Behavior
   - 1.1 Consumer Behavior and International Marketing
   - 1.2 Consumer Decision-Making in the Marketplace
2. The Consumer Decision-Making Process
   - 2.1 The Pre-Purchase Stage
   - 2.2 The Purchase Stage
   - 2.3 The Post-Purchase Stage

3. Internal Influences on Consumer Behavior
   - 3.1 Motives and Motivation
   - 3.2 Perception
   - 3.3 Attitude

4. External Influences on Consumer Behavior
   - 4.1 Culture
   - 4.2 Subculture
   - 4.3 Groups and Families

5. International Consumer Behavior
   - 5.1 Cultural Dimensions
   - 5.2 The Influence of Social Media on Consumer Decision-Making

6. International Marketing Strategy and Consumer Behavior
   - 6.1 International Market Segmentation and Product Positioning
   - 6.2 Consumer Behavior and Product Strategy
   - 6.3 Consumer Behavior and Communication Strategy
   - 6.4 Consumer Behavior and Pricing Strategy
   - 6.5 Consumer Behavior and Distribution Strategy

**Literature**

**Compulsory Reading**

**Further Reading**


- Schiffman, L. G., & Kanuk, L. L. (2014). Consumer behavior. Frenchs Forest.: Pearson Education Australia.
- Solomon, M. (2016). Consumer behavior: Buying, having, and being (12th ed.). New York City, NY: Pearson.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Applied Marketing Research

**Course Code: DLMBCBR02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMBCBR01 |

**Course Description**

In a global economy characterized by greater competition, companies operating internationally need comprehensive market-driven strategies in order to survive in the market place. The course allows students to explore marketing research, the information-gathering arm of marketing practice. The topic is viewed primarily from the perspective of a consumer of marketing research, i.e. a busy manager who needs information to guide decision making. Given their role in decision-making regarding marketing and sourcing marketing research, it is helpful for managers to understand how producers of research approach the process. This background will help you as a manager to become a better-informed consumer of research who is able to participate in research design, evaluate the quality of marketing information that crosses your desk, and conduct marketing research projects yourself when appropriate.

**Course Outcomes**

On successful completion, students will be able to

- recognize and promote the importance of marketing research methodologies in supporting key marketing management decisions.
- identify some of the challenges of marketing research in an international environment.
- identify appropriate analysis tools for a given marketing related problem on a strategic and operational level.
- identify errors made in the research process.
- Outline the stages of the marketing research process.
- identify ethics problems in a marketing research situation and propose an ethically sound approach.
- propose a research design to study a particular research question.
- compare and contrast different research methods.
- recommend good practice for a variety of research techniques.
- Design questionnaires with sound measurement properties.
- interpret results of advanced marketing research efforts.
- transfer the gained insights into their future international work environment.

**Contents**

1. The Role of Marketing Research in Managerial Decision-Making
   - 1.1 The Importance of Marketing Research in Decision-Making
   - 1.2 The Institutions Involved in Marketing Research
   - 1.3 Common Challenges in Conducting Marketing Research

2. Problem Definition and the Marketing Research Process
   2.1 From Problem Recognition to Research Objectives: Step One
   2.2 From Research Design to Follow-Up: Steps Two to Six
   2.3 Forward and Backward Linkages in the Marketing Research Process

3. Secondary Data and Qualitative Research
   3.1 Advantages and Limitations of Secondary Data
   3.2 Definition and Types of Qualitative Research
   3.3 Limitations of Qualitative Research

4. Survey Research and the Concept of Measurement
   4.1 Survey Errors and Their Impact on Research Outcomes
   4.2 Measurement Scales
   4.3 Questionnaire Design

5. Observational Research
   5.1 Observational Research Defined
   5.2 Approaches to Observational Research
   5.3 Advantages and Limitations of Observational Research

6. Sampling Issues, Data Processing, and Fundamental Data Analysis
   6.1 Sampling Methods and Types of Samples
   6.2 Data Processing Issues
   6.3 Fundamental Data Analysis

7. Communicating the Research Results
   7.1 The Major Steps in Communicating the Results
   7.2 Organization of the Research Report
   7.3 The Marketing Research Presentation

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Aaker, D. A., Kumar, V., Leone, R., & Day, G. S. (2012). Marketing research (11th ed.). Hoboken, NJ: John Wiley & Sons.<br>▪ Grover, R., & Vriens, M. (2006). The handbook of marketing research: Uses, misuses, and future advances. Thousand Oaks, CA: Sage Publications.<br>▪ Iacobucci, D., & Churchill, G. A. (2015). Marketing research: Methodological foundations (11th ed.). Mason, OH: South-Western Thomson Learning.<br>▪ Malhotra, N. K., Birks, D. F., & Wills, P. A. (2012). Marketing research: An applied approach (4th ed.). Harlow: Pearson. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Corporate Finance

**Module Code: DLMBCF**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | MBA MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Anke Haag (Corporate Finance) / Prof. Dr. Andreas Simon (Advanced Corporate Finance)

**Contributing Courses to Module**

- Corporate Finance (DLMINRE01)
- Advanced Corporate Finance (DLMBCFIE01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Corporate Finance<br>• Study Format "Distance Learning": Exam, 90 Minutes<br>Advanced Corporate Finance<br>• Study Format "Distance Learning": Module Exam |

**Weight of Module**

see curriculum

**Module Contents**

**Corporate Finance**

- Portfolio and capital market theory and analysis
- Financing types, capital structure, and capital budgeting
- Company valuation procedures
- Acquisitions, corporate control and governance
- Finance planning
- Financing decisions and issuing securities
- Dividend policy and capital structure
- Debt financing and leasing
- Options and futures
- Takeovers, corporate control, and governance
- Solved and unsolved issues and the future of finance

**Advanced Corporate Finance**

**Learning Outcomes**

**Corporate Finance**

On successful completion, students will be able to

- know the key components of corporate finance.
- use financial mathematical methods.
- apply the previously learned methods by using selected data sets and case studies.
- understand the capital structures of a corporation as well as their need to make investment and funding decisions.
- apply the common methods of business valuation and understand the basics of mergers & acquisitions.

**Advanced Corporate Finance**

On successful completion, students will be able to

- identify methods of issuing corporate debt and equity securities, and understand the role of financial intermediaries.
- discuss dividend policy and corporate capital structure in perfect markets vis-à-vis imperfect markets.
- utilize a range of tools for valuing different kinds of debt.
- describe various financing options and their different forms of application in the context of corporate finance.
- discuss mergers and takeovers and the role of different parties involved in the transaction process.

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
| --- | --- |
| This module is similar to other modules in the fields of Finance & Tax Accounting | All Master Programmes in the Business & Management fields |

# Corporate Finance

**Course Code: DLMINRE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MBA | English | | 5 | None |

**Course Description**

How is funding provided to a corporate activity? How much loan capital and/or own capital does one need? Which projects are worth investing in? What is the actual value of a company? What instruments are available to measure the value of a company and assess financial markets? How can one ensure an optimal balance between the competing goals of liquidity, safety, yield, and growth?This course offers answers to these and other complex questions on the topic of financing and investing. The introduction deals with portfolio selection and capital market theory. With this theoretical foundation, various financing types and capital structures are then explained in detail. Well-known corporate assessment procedures, such as the discounted cash flow method, are presented, as are different calculations that can be used to inform decision making. A critical element of the course is the topic of mergers and acquisitions. Case studies are included to illustrate which parties are typically involved in a merger or acquisition and what criteria is used to determine the success of such a venture. The course concludes with the topic of finance planning.

**Course Outcomes**

On successful completion, students will be able to

- know the key components of corporate finance.
- use financial mathematical methods.
- apply the previously learned methods by using selected data sets and case studies.
- understand the capital structures of a corporation as well as their need to make investment and funding decisions.
- apply the common methods of business valuation and understand the basics of mergers & acquisitions.

**Contents**

1. Portfolio and Capital Market Theory
   - 1.1 Capital Markets and Informational Efficiency
   - 1.2 Portfolio Theory
   - 1.3 CAPM
2. Stock and Portfolio Analysis
   - 2.1 Measures of Risk and Performance
   - 2.2 Stock Analysis

3. Optimal Capital Structure
   - 3.1 Capital Structure Based on the Traditional Theorem
   - 3.2 Capital Structure According to Modigliani/Miller
   - 3.3 Neo-Institutional Capital Structure Model

4. Types of Financing
   - 4.1 Internal and External Financing
   - 4.2 Debt Financing
   - 4.3 Equity Financing
   - 4.4 Additional Financing Options

5. Capital Budgeting
   - 5.1 Fundamental Concepts
   - 5.2 Static Capital Budgeting Methods
   - 5.3 Dynamic Investment Calculation Methods

6. Business Valuation
   - 6.1 Purpose and Methods of Business Valuation
   - 6.2 Individual Valuation Methods
   - 6.3 Total Valuation Methods
   - 6.4 Weighted Average Cost of Capital (WACC)

7. Corporate Control and M&A
   - 7.1 The Market for Corporate Control: Mergers and Acquisitions
   - 7.2 Motivations for M&A Transactions
   - 7.3 Phases of M&A Transactions

8. Specific Forms of M&A, Private Equity, Due Diligence, and IPOs
   - 8.1 Due Diligence
   - 8.2 Friendly and Hostile Takeovers, LBOs, MBOs, and MBIs, and IPOs
   - 8.3 Private Equity & Venture Capital Companies

9. Corporate Governance
   - 9.1 Internal and External Corporate Governance
   - 9.2 Example of Legal Basis: Sarbanes Oxley Act (SOX)
   - 9.3 Effect on the Company Performance and the Significance of Ownership Structures
   - 9.4 Additional Financing Options

10. Financial Planning
    - 10.1 Principles of Financial Planning
    - 10.2 Cash Budgeting
    - 10.3 Projected Financial Statements and Ratios

**Literature**

**Compulsory Reading**

**Further Reading**


- Brealey, R. A., & Myers, S. C. (2013). Principles of corporate finance (11th ed.). New York, NY: McGraw-Hill.
- Brealey, R. A., Myers, S. C., & Marcus, A. J. (2011). Fundamentals of corporate finance (7th ed.). New York, NY: McGraw-Hill.
- Brigham, E. F., & Daves, P. R. (2013). Intermediate financial management (11th ed.). Boston, MA: Cengage.
- Copeland, T. E., Weston, J. F., & Shastri, K. (2013). Financial theory and corporate policy (4th ed.). Essex: Pearson.
- Damodaran, A. (2010). Applied corporate finance (3rd ed.). Hoboken, NJ: Wiley & Sons.
- Damodaran, A. (2001). Corporate finance: Theory and practice (2nd ed.). Hoboken, NJ: Wiley & Sons.
- Megginson, W. L., Smart, S. B., & Gitman, L. J. (2010). Corporate finance: Linking theory to what companies do (3rd ed.). Boston, MA: Cengage.
- Ross, S. A., Westerfield, R. W., & Jaffe, J. (2011). Corporate finance, core principles and applications (6th ed.). New York, NY: McGraw-Hill.
- Weston, F. J., Mitchell, M., & Mulherin, H. (2014). Takeovers, restructuring, and corporate governance (4th ed.). Essex: Pearson.
- Ernst, D., & Häcker, J. (2011). Applied international corporate finance (2nd ed.). Munich: Vahlen.
- Schmeisser, W. (2010). Corporate finance and risk management. Munich: Oldenbourg.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Advanced Corporate Finance

**Course Code: DLMBCFIE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The last decade has seen fundamental changes in financial markets and financial instruments. Both the theory and practice of corporate finance have been moving ahead with uncommon speed. Participants will be guided through the main areas of modern financial theory, including the pricing of assets and derivatives, corporate financial policy, and corporate control. The course emphasizes the modern fundamentals of the theory of finance and brings the theory to life with contemporary examples.

**Course Outcomes**

On successful completion, students will be able to

- identify methods of issuing corporate debt and equity securities, and understand the role of financial intermediaries.
- discuss dividend policy and corporate capital structure in perfect markets vis-à-vis imperfect markets.
- utilize a range of tools for valuing different kinds of debt.
- describe various financing options and their different forms of application in the context of corporate finance.
- discuss mergers and takeovers and the role of different parties involved in the transaction process.

**Contents**

1. Financing Decisions and Issuing Securities
   - 1.1 Types of Corporate Financing
   - 1.2 Corporations and Issuing Shares
   - 1.3 Corporations and Issuing Debt Securities
2. Dividend Policy and Capital Structure
   - 2.1 What's Your Dividend Policy?
   - 2.2 What's Your Debt Policy?
   - 2.3 Weighted Average Cost of Capital (WACC)
   - 2.4 Corporate and Personal Taxes
   - 2.5 Capital Structure and Related Theories

3. Debt Financing and Leasing
   - 3.1 Debt Valuation
   - 3.2 Rating Debt
   - 3.3 Different Kinds of Debt and Hybrid Securities
   - 3.4 Leasing as a Form of Corporate Finance

4. Options and Futures
   - 4.1 Derivative Financial Instruments, Options and Futures
   - 4.2 Valuing Options, the Binomial Model, the Black-Scholes Formula
   - 4.3 Real Options

5. Takeovers, Corporate Control, and Governance
   - 5.1 Mergers and Acquisitions
   - 5.2 LBOs, Management Buyouts, and Going Private
   - 5.3 Private Equity and the Venture Capitalist
   - 5.4 Empirical Testing of Takeover Success
   - 5.5 Corporate Governance and Corporate Control

6. Unsolved Issues and the Future of Finance
   - 6.1 What Do We Know and What Do We Not Know About Finance?
   - 6.2 The Future of Finance

**Literature**

**Compulsory Reading**

**Further Reading**

- Brealey, R., Myers, S. C., & Allen, F. (2016). Principles of corporate finance (12th ed.). New York, NY: McGraw-Hill Education.
- Vernimmen, P., Quiry, P., Dallocchio, M., Le Fur, Y., & Salvi, A. (2014). Corporate finance: Theory and practice (4th ed.). Hoboken, NJ: John Wiley & Sons. (Database: EBSCO).

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Module Exam |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☑ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Innovate and Change

**Module Code: DLMDSEIAC-01**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA MBA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. René Schmidpeter (Change Management) / Prof. Dr. Georg Berkel (Innovation and Entrepreneurship)

**Contributing Courses to Module**

- Change Management (DLMBCM01)
- Innovation and Entrepreneurship (DLMBIE01-01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Change Management<br>• Study Format "Distance Learning": Written Assessment: Case Study<br>Innovation and Entrepreneurship<br>• Study Format "Kombistudium": Exam, 90 Minutes<br>• Study Format "Distance Learning": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**Change Management**

- The context and meaning of change
- The change process
- Perspectives for understanding change
- Implementing change

**Innovation and Entrepreneurship**

- Innovation management and entrepreneurship in a globalized world
- Basics of entrepreneurship
- Business ideas and company foundations
- Financing sources and processes
- Internet, digital business, and artificial intelligence
- Strategic alliances
- Family-owned companies

**Learning Outcomes**

**Change Management**

On successful completion, students will be able to

- recognize common features of organizational change and anticipate some of the standard difficulties encountered when an organization engages in change processes.
- explain the importance of organizational change.
- develop a conceptual framework for planned and improvised organizational change, and differentiate between anticipated, emergent, and opportunity-based change.
- utilize and redesign formal organizational structures to facilitate change processes.
- recognize the role of informal organizational structures and identify key stakeholders to promote change processes.
- analyze the social networks that exist within an organization, map independencies and motives/interests, and plan how to distribute information and redesign work flows.
- differentiate between groups of stakeholders and identify the most suitable strategy to adopt with each group.
- recognize the role of the change leader as a political broker and build social capital through informal methods.
- utilize stories and symbols when communicating with others in an organization to maximize leverage as a cultural change leader.
- draw on empirical evidence to plan and implement change processes in an organization.

**Innovation and Entrepreneurship**

On successful completion, students will be able to

- understand the importance, fundamentals, and dimensions of entrepreneurship and its derivatives (intrapreneurship, corporate entrepreneurship, stakeholder relationships, and family businesses).
- analyze the opportunities and challenges associated with evaluating a business idea and setting up a business.
- distinguish between the different motivations behind entrepreneurial activity and develop specific objectives for new enterprises.
- develop a business model, including benchmarks for assessing desired sustainable growth.
- apply different legal forms to business start-ups and select the appropriate legal form for a specific business model.
- understand the different ways in which entrepreneurship and innovation can be financed and weigh them against each other in terms of medium- and long-term advantages and disadvantages.
- develop a rigorous business plan that can be used both as a planning and financing instrument.
- apply, in principle, an entrepreneurial mindset in a variety of different contexts of future professional development.

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
| --- | --- |
| This module is similar to other modules in the fields of Business Administration & Management | All Master Programmes in the Business & Management fields |

# Change Management

**Course Code: DLMBCM01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

We live in a world characterized by constant change. This affects not only individuals but also organizations. Even successful organizations need to constantly reinvent themselves in order to remain successful. This course presents a discussion of change in relation to the complexities of organizational life, with an emphasis on applying theory to actual practice. Organizational change is an international phenomenon and the course includes many international case examples. With a focus on organizational change as opposed to personal change and/or entrepreneurship, this course has a distinctly different focus from the related modules “Leadership” and “Innovation and Entrepreneurship.” The first part of the course considers the nature of change and different change models. The second part focuses on how different perspectives complement one another and can be used to better understand, analyze, and diagnose change processes. The course deals with issues of structure, culture, and politics. In the later part of the course, the implementation of change is considered in detail. Given that many change processes fail, this part is an important learning component to complement an in-depth understanding of change.

**Course Outcomes**

On successful completion, students will be able to

- recognize common features of organizational change and anticipate some of the standard difficulties encountered when an organization engages in change processes.
- explain the importance of organizational change.
- develop a conceptual framework for planned and improvised organizational change, and differentiate between anticipated, emergent, and opportunity-based change.
- utilize and redesign formal organizational structures to facilitate change processes.
- recognize the role of informal organizational structures and identify key stakeholders to promote change processes.
- analyze the social networks that exist within an organization, map independencies and motives/interests, and plan how to distribute information and redesign work flows.
- differentiate between groups of stakeholders and identify the most suitable strategy to adopt with each group.
- recognize the role of the change leader as a political broker and build social capital through informal methods.
- utilize stories and symbols when communicating with others in an organization to maximize leverage as a cultural change leader.
- draw on empirical evidence to plan and implement change processes in an organization.

**Contents**

1. Organizational Change
   - 1.1 What is Organizational Change About?
   - 1.2 Organizational Change is Ubiquitous
   - 1.3 Change is Difficult

2. Change Management
   - 2.1 The Context of Organizational Change
   - 2.2 Planned Versus Improvisational Change Management
   - 2.3 The Congruence Model of Change

3. Designing Structure
   - 3.1 Formal Structure in Organizations
   - 3.2 Grouping
   - 3.3 Linking
   - 3.4 The Change Leader as an Architect

4. Social Networks
   - 4.1 What are Social Networks?
   - 4.2 Key Terms of Social Network Analysis
   - 4.3 Unique Characteristics of Social Networks
   - 4.4 Social Networks and Organizational Change

5. Politics
   - 5.1 Organizations as Political Arena
   - 5.2 Politics and Change
   - 5.3 The Importance of a Political Perspective on Change

6. Sense-Making
   - 6.1 Organizational Culture
   - 6.2 Sense-Making in Organizations
   - 6.3 The Change Leader as Shaman

7. Change Implementation
   - 7.1 How to Implement Change Successfully
   - 7.2 Four Perspectives on Change

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Bolman, L. G., & Deal, T. E. (2013). Reframing organizations: Artistry, choice, and leadership (5th ed.). San Francisco, CA: Jossey-Bass.Cameron, K. S., & Quinn, R. E. (2011). Diagnosing and changing organizational culture: Based on the competing values framework (3rd ed.). San Francisco, CA: Jossey-Bass.Pentland, A. (2014). Social physics: How good ideas spread – The lessons from a new science. New York, NY: Penguin Press.McChrystal, S., Collins, T., Silverman, D., & Fussell, C. (2015). Team of teams: New rules of engagement for a complex world. New York, NY: Penguin Press.Worren, N. A. M. (2012). Organisation design: Re-defining complex systems. Harlow: Pearson. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Case Study |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Innovation and Entrepreneurship

**Course Code: DLMBIE01-01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MBA | English | | 5 | None |

**Course Description**

In today's globalized and digital world, entrepreneurs have more opportunities to develop and market products and services than ever before. However, entrepreneurship, whether in the form of entrepreneurship or intrapreneurship, presents special challenges. In order to avoid the typical pitfalls of starting and growing a business, a sound understanding of innovation management and building a business is essential. Particular attention must be paid to the financing of entrepreneurial activity, both from the perspective of the entrepreneur and the investor. Innovation and entrepreneurial activity are the basis and driving force of our economy. Even looking at other economies, it is obvious that innovation and entrepreneurship are crucial at every stage of economic development. Small enterprises in developing countries initiate the development of economic institutions and create supply, demand, and markets. These enterprises lay the foundation for economic development and growth. In developed economies, innovation and entrepreneurship are the driving forces behind competition and competitiveness in the global context. In all parts of the world, family businesses play the most important role. The rapid technological and social change present in our societies requires the innovative use of digital technologies (internet and artificial intelligence), as well as flexibility in handling new forms of organization (e.g., strategic alliances between companies). This course introduces students to the ideas behind, motives, and drivers of entrepreneurial activity and innovation and teaches them the practical aspects of the identification, analysis, and development of innovations and business ideas. The core competence of the entrepreneur—the ability to negotiate with investors and partners—is also addressed.

**Course Outcomes**

On successful completion, students will be able to

- understand the importance, fundamentals, and dimensions of entrepreneurship and its derivatives (intrapreneurship, corporate entrepreneurship, stakeholder relationships, and family businesses).
- analyze the opportunities and challenges associated with evaluating a business idea and setting up a business.
- distinguish between the different motivations behind entrepreneurial activity and develop specific objectives for new enterprises.
- develop a business model, including benchmarks for assessing desired sustainable growth.
- apply different legal forms to business start-ups and select the appropriate legal form for a specific business model.
- understand the different ways in which entrepreneurship and innovation can be financed and weigh them against each other in terms of medium- and long-term advantages and disadvantages.
- develop a rigorous business plan that can be used both as a planning and financing instrument.
- apply, in principle, an entrepreneurial mindset in a variety of different contexts of future professional development.

**Contents**

1. Entrepreneurship
   - 1.1 Entrepreneurship and entrepreneur
   - 1.2 Enterprise related theories of entrepreneurship
   - 1.3 The economic significance of entrepreneurship
2. Company formation strategy
   - 2.1 Different contexts in which companies are founded
   - 2.2 The Entrepreneur
   - 2.3 Business models and strategies
3. Innovation and innovation management
   - 3.1 Innovation
   - 3.2 Innovation management
   - 3.3 Protection of intellectual property
   - 3.4 Case study: BMW Empathic Design
4. Legal form in international comparison
   - 4.1 Germany
   - 4.2 International comparison: USA

5. Financing entrepreneurial activity I: Sources of finance
   - 5.1 Incubators, accelerators and crowdfunding
   - 5.2 Business angels
   - 5.3 Private equity and corporate venture capital
   - 5.4 Public start-up support

6. Financing entrepreneurial activity II: Financing processes
   - 6.1 The investor view: Deal sourcing and deal screening
   - 6.2 The entrepreneurial view: Negotiations with investors
   - 6.3 The evaluation of business start-ups

7. The business plan
   - 7.1 Purpose and objectives of the business plan
   - 7.2 Expectations regarding the business plan
   - 7.3 Structure and content of the business plan
   - 7.4 Guidelines for creating a business plan

8. Digital business models and artificial intelligence
   - 8.1 e-Business
   - 8.2 Artificial intelligence
   - 8.3 The Globotics Evolution

9. Cooperative strategy: Alliances and joint ventures
   - 9.1 Cooperative strategy
   - 9.2 The right “fit”
   - 9.3 The right “form”

10. Family-owned company
    - 10.1 Definitions
    - 10.2 Economic significance
    - 10.3 Strengths and weaknesses

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Alemany L. /Andreoli J.: (2018): Entrepreneurial Finance. The Art and Science of Growing Ventures, Cambridge University Press.<br>▪ Barringer, B. R./Ireland, R. D. (2019): Entrepreneurship. Successfully Launching New Ventures. 6. Auflage, Pearson Harlow (UK).<br>▪ Bertrand, M. /Schoar, A. (2006). The role of family in family firms. Journal of economic perspectives, 20(2), 73-96.<br>▪ Bessant, J./Tidd, J. (2011): Innovation and Entrepreneurship. 2. Auflage, Wiley, Chichester (UK).<br>▪ Child J. /Faulkner D. /Tallmann S. /Hsieh L. (o.J):. Cooperative Strategy: Managing Alliances and Networks, 3. Auflage, Oxford University Press.<br>▪ Dinnar, S. /Susskind, L. E. (2019): Entrepreneurial Negotiation. Understanding and Managing the Relationships that Determine Your Entrepreneurial Success, Springer.<br>▪ Evans, V. (2015): Writing a Business Plan. How to Win Backing to Start Up or Grow Your Business. 2nd Edition Pearson, Harlow (UK).<br>▪ Fleming, L. (2007): Breakthroughs and the 'Long tail' of innovation. In: MIT Sloan Management Review, 49. Jg., Heft 1, S. 69–74.<br>▪ Richard Baldwin (2019): The Globotics Upheaval: Globalisation, Robotics and the Future of Work.<br>▪ Scarborough, N. M. (2012): Essentials of Entrepreneurship and Small Business Management. 7. Auflage, Pearson, Harlow (UK), S. 17–47.<br>▪ Simon C. Parker (2018): The Economics of Entrepreneurship, 2nd Edition, Cambridge University Press.<br>▪ Thomas Zellweger (2017): Managing the Family Business, Elgar. |

### Study Format Kombistudium

| Study Format | Course Type |
|---|---|
| Kombistudium | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Cognitive Computing

**Module Code: DLMDSECC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | ▪ DLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV01<br>▪ DLMDSAM, DLMDSPWP, DLMDSML | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Tim Schlippe (NLP and Computer Vision) / Prof. Dr. Tim Schlippe (Advanced NLP and Computer Vision)

**Contributing Courses to Module**

- NLP and Computer Vision (DLMAINLPCV01)
- Advanced NLP and Computer Vision (DLMAIEAIS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | NLP and Computer Vision<br>• Study Format "Distance Learning": Oral Assignment<br>Advanced NLP and Computer Vision<br>• Study Format "Distance Learning": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**NLP and Computer Vision**

- Important methods in computer vision and NLP
- Relevant applications in both domains
- Security and privacy implications of computer vision and NLP

**Advanced NLP and Computer Vision**

- Machine translation and semantic text interpretation
- Recovery of scene geometry
- Semantic image and video analysis
- Object tracking

**Learning Outcomes**

**NLP and Computer Vision**

On successful completion, students will be able to

- name important problems in natural language and image processing.
- recognize the common algorithms and methods to address said problems.
- understand common use-case scenarios in which NLP and computer vision techniques are applied.
- analyze the advantages and drawbacks of various NLP and computer vision algorithms.
- reflect on pertinent implications of NLP and computer vision technology with respect to privacy and security.

**Advanced NLP and Computer Vision**

On successful completion, students will be able to

- name core aspects of advanced computer vision and NLP problems and techniques.
- summarize current approaches to problems in text and speech processing.
- recognize promising developments in scene understanding and semantic image analysis.
- remember challenges and solution strategies in single and multiple object tracking.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# NLP and Computer Vision

**Course Code: DLMAINLPCV01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM, DLMDSPWP, DLMDSML |

**Course Description**

This course elucidates contemporary approaches to computer vision and natural language processing. In order to achieve this goal, two problem domains are introduced with a comprehensive overview on related topics and techniques. It is then demonstrated how related tasks arise in relevant application scenarios. Finally, an outlook on privacy and security aspects is provided in order to sensitize the students to pressing questions in this domain.

**Course Outcomes**

On successful completion, students will be able to

- name important problems in natural language and image processing.
- recognize the common algorithms and methods to address said problems.
- understand common use-case scenarios in which NLP and computer vision techniques are applied.
- analyze the advantages and drawbacks of various NLP and computer vision algorithms.
- reflect on pertinent implications of NLP and computer vision technology with respect to privacy and security.

**Contents**

1. Introduction to NLP
   - 1.1 What is NLP?
   - 1.2 Regular expressions, tokenization & stop-words
   - 1.3 Bag of Words and word vectors
   - 1.4 N-Grams: Grouping related words
   - 1.5 Word sense disambiguation
   - 1.6 NLP with Python
2. Applications of NLP
   - 2.1 Topic identification and text summary
   - 2.2 Sentiment analysis
   - 2.3 Named entity recognition
   - 2.4 Translation
   - 2.5 Chatbots

3. Introduction to Computer Vision
   - 3.1 What is computer vision?
   - 3.2 Pixels and filters
   - 3.3 Feature detection
   - 3.4 Distortion and calibration
   - 3.5 Multiple & stereo vision
   - 3.6 Computer vision with Python

4. Applications of Computer Vision
   - 4.1 Image classification, motion tracking
   - 4.2 Semantic segmentation
   - 4.3 Object identification & tracking
   - 4.4 Eigenfaces and facial recognition

5. Privacy and Security
   - 5.1 Adversarial image attacks
   - 5.2 Privacy of visual data & privacy preserving visual features
   - 5.3 Wearable and mobile camera privacy

**Literature**

**Compulsory Reading**

**Further Reading**


- Bird S., Klein, E., & Loper, E. (2009). Natural language processing with Python (2nd ed.). Sebastopol, CA: O'Reilly.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., & Williams, C. K. I. (2016). Dictionary of computer vision and image processing. Chichester: John Wiley & Sons.
- Jurafsky, D. & Martin, J. H. (2008). Speech and language processing. Upper Saddle River, NJ: Prentice Hall.
- Szelski, R. (2011). Computer vision: Algorithms and applications (2nd ed.). Wiesbaden: Springer VS.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Oral Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Advanced NLP and Computer Vision

**Course Code: DLMAIEAIS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV01 |

**Course Description**

This course expands upon the material presented in the introductory NLP and Computer Vision course. With respect to the processing of text, it provides an overview of machine translation and information extraction. Moreover, it addresses signal processing aspects of NLP such as speech recognition and synthesis. Additionally, important concepts from the subject domain of computer vision such as the recovery of scene geometry, the semantic analysis of still and video imagery, and object tracking are discussed.

**Course Outcomes**

On successful completion, students will be able to

- name core aspects of advanced computer vision and NLP problems and techniques.
- summarize current approaches to problems in text and speech processing.
- recognize promising developments in scene understanding and semantic image analysis.
- remember challenges and solution strategies in single and multiple object tracking.

**Contents**

1. Text Processing
   - 1.1 Machine translation
   - 1.2 Information extraction
2. Speech Signal Processing
   - 2.1 Speech recognition
   - 2.2 Speech synthesis
3. Geometry Reconstruction
   - 3.1 3D reconstruction from 2D images/videos
   - 3.2 Change of perspective

4. Semantic Image Analysis
   - 4.1 Image retrieval
   - 4.2 Semantic segmentation / object detection
   - 4.3 Medical imaging analysis
   - 4.4 Copyright violation, counterfeit and forgery detection
   - 4.5 Face recognition and biometrics

5. Tracking
   - 5.1 Challenges in tracking
   - 5.2 Object representation
   - 5.3 Single vs. multiple object tracking

**Literature**

**Compulsory Reading**

**Further Reading**


- Bengfort, B., & Ojeda, T. (2018). Applied text analysis with Python: Enabling language aware data products with machine learning. Sebastopol, CA: O'Reilly.
- Clark, A., Fox, C., & Lappin, S. (Eds.). (2010). Handbook of computational linguistics and natural language processing. Malden, MA: Wiley-Blackwell.
- Davies, E. R. (2017). Computer vision: Principles, algorithms, applications, learning (5th ed.). Cambridge, MA: Academic Press.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., Williams, C. K. I. (2016). Dictionary of computer vision and image processing. Chichester: John Wiley & Sons Ltd.
- Jurafsky, D., & Martin, J. H. (2008). Speech and language processing. Boston, MA: Prentice Hall.
- Szelski, R. (2011). Computer vision: Algorithms and applications (2nd ed.). Wiesbaden: Springer VS.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Applied Autonomous Driving

**Module Code: DLMDSEAAD**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Benjamin Lehmann (Architectures of Self-Driving Vehicles) / Dr. Benjamin Lehmann (Case Study: Localization, Motion Planning and Sensor Fusion)

**Contributing Courses to Module**

- Architectures of Self-Driving Vehicles (DLMDSEAAD01)
- Case Study: Localization, Motion Planning and Sensor Fusion (DLMDSEAAD02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Architectures of Self-Driving Vehicles<br>• Study Format "Distance Learning": Exam, 90 Minutes<br>Case Study: Localization, Motion Planning and Sensor Fusion<br>• Study Format "Distance Learning": Written Assessment: Case Study |

**Weight of Module**

see curriculum

**Module Contents**

**Architectures of Self-Driving Vehicles**

- Architectural patterns of a self-driving car
- Perception and motion control
- Social impact of autonomous vehicles

**Case Study: Localization, Motion Planning and Sensor Fusion**

- Algorithms for localization and navigation
- Sensor fusion methods for localization and objects tracking
- Motion planning algorithms

**Learning Outcomes**

**Architectures of Self-Driving Vehicles**

On successful completion, students will be able to

- explain and recognize the main components of a self-driving car.
- distinguish the sensor solutions for a self-driving car and adopt the best one for a given scenario.
- model and implement a simple motion control system.
- manage the main communication protocols to retrieve valuable information.
- reflect on the social impact of self-driving cars.

**Case Study: Localization, Motion Planning and Sensor Fusion**

On successful completion, students will be able to

- distinguish the methods used for localization, motion planning, and sensor fusion.
- apply the methods to autonomous vehicles.
- understand the main issues related to the adoption of autonomous vehicles in real-world scenarios.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the field of Engineering | All Master Programmes in the IT & Technology fields |

# Architectures of Self-Driving Vehicles

**Course Code: DLMDSEAAD01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

This course gives an overview of the main architectural aspects of a self-driving car. After introducing the hardware and software platforms, the course presents the sensor solutions necessary to provide environment perception for autonomous vehicles. Such perception yields the information used for motion control, including braking and steering. The fundamental concepts for the realization and implementation of motion control are presented, together with related safety issues (e.g., motion control under false information). The way in which a self-driving car exchanges information with the outside world is also discussed, and the main technologies and protocols are introduced. The last part of the course elaborates on the social impact of self-driving cars: ethics, mobility, and design.

**Course Outcomes**

On successful completion, students will be able to

- explain and recognize the main components of a self-driving car.
- distinguish the sensor solutions for a self-driving car and adopt the best one for a given scenario.
- model and implement a simple motion control system.
- manage the main communication protocols to retrieve valuable information.
- reflect on the social impact of self-driving cars.

**Contents**

1. Introduction
   - 1.1 Basic concepts and key technologies
   - 1.2 Hardware overview
   - 1.3 Software overview
   - 1.4 State of the art and open challenges
   - 1.5 Trends

2. Environment Perception
   - 2.1 Basic concepts
   - 2.2 GPS
   - 2.3 Inertial sensors
   - 2.4 Lidar and Radar
   - 2.5 Cameras

3. Moving, Braking, Steering
   - 3.1 Fundamentals
   - 3.2 Dynamics of a mobile vehicle
   - 3.3 Braking technologies
   - 3.4 Lateral and longitudinal control
   - 3.5 Safety issues

4. Communication
   - 4.1 Car2X communication
   - 4.2 Protocols
   - 4.3 Safety issues

5. Social Impact
   - 5.1 Ethics for autonomous vehicles
   - 5.2 New mobility
   - 5.3 Autonomous vehicles and design

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Ben-Ari, M., & Mondada, F. (2018). Elements of robotics . Cham: Springer.<br>▪ Cheng, H. (2011). Autonomous intelligent vehicles . London: Springer.<br>▪ Fazlollahtabar, H., & Saidi-Mehrabad, M. (2015). Autonomous guided vehicles . Cham: Springer.<br>▪ Maurer, M., Gerdes, J. C., Lenz, B., & Winner, H. (Eds.). (2016). Autonomous driving . Berlin, Heidelberg: Springer.<br>▪ Miucic, R. (Ed.). (2019). Connected vehicles . Cham: Springer.<br>▪ Yu, H., Li, X., Murray, R. M., Ramesh, S., & Tomlin, C. J. (Eds.). (2019). Safe, autonomous and intelligent vehicles . Cham: Springer. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Case Study: Localization, Motion Planning and Sensor Fusion

**Course Code: DLMDSEAAD02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

This course provides the fundamental concepts and methods of localization, motion planning, and sensor fusion for mobile robotics and self-driving cars. Mobile robots and autonomous vehicles rely on the ability to perceive the environment and react to its dynamic changes.The first part of the course focuses on the representation of motion and navigation based on odometry, which is affected by errors due to information uncertainty. A possible solution is offered by localization methods which use odometry and complementary information, such as a GPS signal, to improve the estimation of the position of the autonomous vehicles within a reference frame. In this way, the vehicle is able to move towards a goal.The problems with detecting dynamic change in the environment is addressed in the last part of the course, where the methods of sensor fusion are introduced. Thanks to the fusion of multiple data sources, information can be extracted, e.g., an approaching object or a change in a situation can be revealed. The autonomous vehicle must be able to track the object and react to its movement to avoid human hazard and damage. The determination of the best trajectory to follow is addressed in the final part of the course.The course gives a hands-on overview of the main methods for localization, motion planning, and sensor fusion. The students must apply the concepts and methods to case studies involving a self-driving vehicle in two main scenarios: “on the road” and in a manufacturing facility.

**Course Outcomes**

On successful completion, students will be able to

- distinguish the methods used for localization, motion planning, and sensor fusion.
- apply the methods to autonomous vehicles.
- understand the main issues related to the adoption of autonomous vehicles in real-world scenarios.

**Contents**

1. Motion and Odometry
   - 1.1 Basic principles
   - 1.2 Motion models
   - 1.3 Navigation by odometry
   - 1.4 Holonomic and non-holonomic motion
   - 1.5 Errors

2. Local Navigation
   - 2.1 Basic concepts
   - 2.2 Path finding
   - 2.3 Obstacle avoidance

3. Localization
   - 3.1 Basic concepts
   - 3.2 Triangulation
   - 3.3 GPS
   - 3.4 Probabilistic localization
   - 3.5 Uncertainty of motion

4. Sensor Fusion
   - 4.1 Sensors
   - 4.2 Elaborating data from sensors
   - 4.3 Kalman filter
   - 4.4 Extended Kalman filter
   - 4.5 Tracking objects

5. Motion Planning
   - 5.1 Path planning
   - 5.2 Motion prediction
   - 5.3 Trajectory generation

**Literature**

**Compulsory Reading**

**Further Reading**


- Koch, W., & Springer-Verlag GmbH. (n.d.). Tracking and sensor data fusion methodological framework and selected applications . Berlin, Heidelberg: Springer.
- Mitchell, H. B. (2007). Multi-sensor data fusion: An introduction . Berlin, Heidelberg: Springer.
- Valencia, R., & Andrade-Cetto, J. (2018). Mapping, planning and exploration with Pose SLAM . Cham: Springer.
- Wang, P. K.-C. (2015). Visibility-based optimal path and motion planning . Cham: Springer.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Case Study |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

DLMDSEAAD02

# Self Learning Systems

**Module Code: DLMDSESLS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | ▪ DLMDSAM, DLMDSAS, DLMDSPWP<br>▪ DLMDSAM, DLMDSPWP, DLMDSML, DLMDSDL | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ulrich Kerzel (Reinforcement Learning) / Prof. Dr. Ulrich Kerzel (Inference and Causality)

**Contributing Courses to Module**

- Reinforcement Learning (DLMAIRIL01)
- Inference and Causality (DLMAIIAC01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Reinforcement Learning<br>• Study Format "Fernstudium": Written Assessment: Written Assignment<br>Inference and Causality<br>• Study Format "Distance Learning": Workbook |

**Weight of Module**

see curriculum

**Module Contents**

**Reinforcement Learning**

- Introduction to reinforcement learning
- Markov chains
- Bandit
- Q-Learning
- Reinforcement learning approaches

**Inference and Causality**

- Statistical inference
- Introduction to causality
- Interventions
- Do-calculus
- Fallacies

**Learning Outcomes**

**Reinforcement Learning**

On successful completion, students will be able to

- understand the concepts of reinforcement learning.
- analyze Markov decision processes.
- evaluate value functions, actions and policies.
- apply Q-Learning methods to reinforcement learning problems.
- summarize model-free and model-based approaches.
- evaluate the tradeoff between exploitation and exploration.

**Inference and Causality**

On successful completion, students will be able to

- examine data in terms of statistical inference.
- create probabilistic models.
- understand the building blocks of causal inference.
- analyze interventions in statistical systems.
- follow the rules of do-calculus.
- evaluate common fallacies in causal analysis.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Reinforcement Learning

**Course Code: DLMAIRIL01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM, DLMDSPWP, DLMDSML, DLMDSDL |

**Course Description**

Reinforcement learning allows computers to derive problem-solving strategies without being explicitly programmed for the specific task, similar to the way humans and animals learn.After introducing the concepts of reinforcement learning, the course discusses the properties of Markov chains and single- and multi-armed bandits in detail. Special attention is given to the understanding of value functions and discounted value functions.The course connects reinforcement learning with neural networks and deep learning and discusses how Q-Learning approaches can be used to utilize deep learning methods in reinforcement learning problems, including extensions such as double Q-Learning, hierarchical learning, and actor-critic learning.Finally, the course discusses reinforcement learning approaches such as model-free and model-based learning and the tradeoff between exploration and exploitation.

**Course Outcomes**

On successful completion, students will be able to

- understand the concepts of reinforcement learning.
- analyze Markov decision processes.
- evaluate value functions, actions and policies.
- apply Q-Learning methods to reinforcement learning problems.
- summarize model-free and model-based approaches.
- evaluate the tradeoff between exploitation and exploration.

**Contents**

1. Introduction to Reinforcement Learning
   - 1.1 Understanding Reinforcement Learning
   - 1.2 Components of Reinforcement Learning Systems

2. Markov Chains
   - 2.1 Markov Decision Process & Markov Property
   - 2.2 Value Functions and Discounted Value Functions
   - 2.3 General Utility Function
   - 2.4 Actions & Policy
   - 2.5 Bellman's Equation
   - 2.6 Value Iteration
   - 2.7 Markov Chain Monte Carlo (MCMC)

3. Bandit
   - 3.1 Single-Arm Bandit
   - 3.2 Multi-Arm Bandit

4. Q-Learning
   - 4.1 Time-difference Learning
   - 4.2 Reinforcement Learning with Neural Networks & Deep Q Learning
   - 4.3 Experience Replay
   - 4.4 Double Q-Learning
   - 4.5 Delayed Sparse Rewards
   - 4.6 Hierarchical Learning
   - 4.7 Value- vs Policy-Based Learning
   - 4.8 Actor Critic Learning

5. Reinforcement Learning Approaches
   - 5.1 Model-Free Learning
   - 5.2 Model-Based Learning
   - 5.3 Exploration vs Exploitation

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Geron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow. Boston, MA: O'Reilly Publishing.<br>▪ Kolobov, A., & Mausam. (2012). Planning with Markov decision processes: An AI perspective . San Rafael, CA: Morgan & Claypool.<br>▪ Powell, W. (2011). Approximate Dynamic Programming (2 nd ed.). Hoboken, NJ: John Wiley & Sons.<br>▪ Sutton, R., & Barto, A. (2018). Reinforcement learning: An introduction (2 nd ed.). Boston, MA: MIT Press.<br>▪ Szepesvári, C. (2010). Algorithms for reinforcement learning. San Rafael, CA: Morgan & Claypool.<br>▪ Wiering, M., & Otterlo, M. (2012). Reinforcement learning: State of the art. Berlin: Springer. |

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Written Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☐ Vodcast
- ☑ Shortcast
- ☑ Audio
- ☑ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☑ Guideline
- ☑ Live Tutorium/Course Feed

# Inference and Causality

**Course Code: DLMAIIAC01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | DLMDSAM, DLMDSAS, DLMDSPWP |

**Course Description**

Statistical inference and causal analysis are crucial tools for analyzing and understanding data on a fundamental level. This course starts with an introduction to Bayesian inference and Bayesian networks which use probabilities to describe statistical problems and introduce probabilistic modelling which allows the specification of Bayesian statistical models in code. This course introduces the concepts of causality, how causality relates to correlation between variables, and discusses the fundamental building blocks of causal analysis. The effect of interventions (i.e., when the experimenter actively changes the setup from which the data are taken) are also discussed. This course then introduces the rules of do-calculus, which allow interventions to be described formally.Finally, the course discusses a wide range of typical fallacies which arise in the context of causal analysis.

**Course Outcomes**

On successful completion, students will be able to

- examine data in terms of statistical inference.
- create probabilistic models.
- understand the building blocks of causal inference.
- analyze interventions in statistical systems.
- follow the rules of do-calculus.
- evaluate common fallacies in causal analysis.

**Contents**

1. Statistical Inference
   - 1.1 Bayesian inference
   - 1.2 Bayesian networks
   - 1.3 Probabilistic modelling
2. Introduction to Causality
   - 2.1 Correlation vs causation
   - 2.2 Granger causality
   - 2.3 Directed Acyclic Graphs (DAG)
   - 2.4 Elements of causal graphs: collider, chain, fork
   - 2.5 D – separation

3. Interventions
   - 3.1 Seeing vs doing
   - 3.2 Conditional independence
   - 3.3 Confounders & counterfactuals
   - 3.4 Causal inference vs randomized controlled trials

4. Do-calculus
   - 4.1 Front- & backdoor criterion
   - 4.2 Three rules of do-calculus

5. Fallacies
   - 5.1 Mediation fallacy
   - 5.2 Collider bias
   - 5.3 Simpson's & Berkson's Paradox
   - 5.4 Imputing missing values: causal vs data-driven view

**Literature**

**Compulsory Reading**

**Further Reading**


- Kruschke, J. (2014). Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan (2nd ed.). Cambridge, MA: Academic Press.
- Martin, O. (2016). Bayesian analysis with Python. Birmingham: Packt Publishing.
- Pearl, J. (2009). Causality (2nd ed.). Cambridge: Cambridge University Press.
- Pearl, J., Glymour, M., & Jewell, M. P. (2016). Causal inference in statistics - A primer. Chichester: John Wiley & Sons.
- Pearl, J., & Mackenzie, D. (2018). The book of why: The new science of cause and effect. New York, NY: Basic Books.
- Peters, J., Janzing, D., & Scholkopft, B. (2017). Elements of causal inference. Cambridge, MA: MIT Press.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Workbook |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☑ Shortcast | ☑ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☐ Exam Template | |

# Industrial Automation and Internet of Things

**Module Code: DLMDSEIAAIT**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Leonardo Riccardi (Industrial Automation) / Prof. Dr. Leonardo Riccardi (Internet of Things)

**Contributing Courses to Module**

- Industrial Automation (DLMDSINDA01)
- Internet of Things (DLMBMMIIT01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Industrial Automation<br>• Study Format "Distance Learning": Module Exam<br>Internet of Things<br>• Study Format "Distance Learning": Exam, 90 Minutes |

**Weight of Module**

see curriculum

**Module Contents**

**Industrial Automation**

- Mathematical frameworks for the formal description of discrete event systems
- Analysis and evaluation methods
- Simulation of discrete event systems
- Supervisory control
- Advanced issues (fault diagnosis, adaptive supervision, optimization)

**Internet of Things**

- Consumer use cases and risks
- Business use cases and risks
- Social-economic issues
- Enabling technologies and networking fundamentals

**Learning Outcomes**

**Industrial Automation**

On successful completion, students will be able to

- identify the main issues related to industrial automation and Industry 4.0 automation in particular.
- describe a discrete event system in a formal way by means of different mathematical models.
- analyze the performance of a system using formalisms and numerical simulation approaches.
- choose the best formalism for a given design scenario and formulate requirements.
- design and implement a supervisory controller to fulfill requirements.
- understand advanced topics related to Industry 4.0 industrial automation.

**Internet of Things**

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
|---|---|
| This module is similar to other modules in the fields of Engineering and Computer Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Industrial Automation

**Course Code: DLMDSINDA01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

Production systems can be described as discrete event systems where the evolution is characterized by the occurrence of events. In the era of Industry 4.0 and highly-flexible manufacturing, there is the need to provide adequate means for the modeling, analysis, design, and control of flexible production environments.This course introduces several modeling approaches for the mathematical description of discrete event systems, such as Automata, Petri Nets, and Markov processes. Each approach is presented in both theory and practice with examples taken from the industry. The approaches are grouped into logic—where only the logic sequence of events determines the evolution—and timed, where the time schedule of the events also plays an important role. Although simple discrete event systems can be analyzed mathematically, complex systems need the support of computer simulation. The main issues concerning the simulation of discrete event systems are addressed.The final part of this course introduces the concept of supervisory control, which aims at changing the properties of a given system to improve specified behaviors and fulfill defined design specifications. Supervisory control is addressed both from the theoretical practical sides, describing how it can be implemented in a modern industrial environment.The course wraps up with discussion of interesting applications for modeling and design approaches, e.g., in the modeling and analysis of an industrial production unit. Additional conversation on topics like fault-diagnosis, decentralized and distributed supervision, optimization, and adaptive supervision provide a contingent connection between classical industrial automation and the recent, (big) data-driven, flexible, Industry 4.0 advanced industrial automation.

**Course Outcomes**

On successful completion, students will be able to

- identify the main issues related to industrial automation and Industry 4.0 automation in particular.
- describe a discrete event system in a formal way by means of different mathematical models.
- analyze the performance of a system using formalisms and numerical simulation approaches.
- choose the best formalism for a given design scenario and formulate requirements.
- design and implement a supervisory controller to fulfill requirements.
- understand advanced topics related to Industry 4.0 industrial automation.

**Contents**

1. Introduction to Production Systems
   - 1.1 Basic concepts and definitions
   - 1.2 Industrial supervision and control
   - 1.3 Challenges
   - 1.4 Trends

2. Automata
   - 2.1 Preliminaries
   - 2.2 Deterministic finite automata
   - 2.3 Non-deterministic finite automata
   - 2.4 Properties

3. Petri nets
   - 3.1 Preliminaries
   - 3.2 Modeling systems
   - 3.3 Properties
   - 3.4 Analysis methods

4. Timed models
   - 4.1 Timed automata
   - 4.2 Markov processes
   - 4.3 Queuing theory
   - 4.4 Timed Petri Nets

5. Simulation of discrete event systems
   - 5.1 Basic concepts
   - 5.2 Working principles
   - 5.3 Performance analysis
   - 5.4 Software tools

6. Supervisory control
   - 6.1 Basic concepts
   - 6.2 Specifications
   - 6.3 Synthesis
   - 6.4 Performance analysis
   - 6.5 Implementation

7. Applications
   - 7.1 Production system supervision
   - 7.2 Monitoring and diagnosis of faults
   - 7.3 Distributed and de-centralized supervision
   - 7.4 Model-based optimization of production systems
   - 7.5 Adaptive supervisory control

**Literature**

**Compulsory Reading**

**Further Reading**


- Cassandras, C. G./Lafortune, S. (Eds.). (2008): Introduction to discrete event systems. Springer, Boston, MA.
- Choi, B. K./Kang, D. (2013): Modeling and simulation of discrete-event systems. Wiley, Hoboken, NJ.
- Ding, D./Wang, Z./Wei, G. (2018): Performance analysis and synthesis for discrete-time stochastic systems with network-enhanced complexities. CRC Press, Boca Raton, FL.
- Hrúz, B./MengChu, Z. (2007): Modeling and control of discrete-event dynamic systems. Springer, London.
- Seatzu, C./Silva, M./van Schuppen, J. H. (Eds.). (2013): Control of discrete-event systems. Springer, London.
- Wonham, W. M./Cai, K. (2019): Supervisory control of discrete-event systems. Springer, Cham.
- Zimmermann, A. (2008): Stochastic discrete event systems. Springer, Berlin/Heidelberg.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Module Exam |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☑ Course Book
- ☐ Vodcast
- ☑ Shortcast
- ☑ Audio
- ☑ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☐ Guideline
- ☐ Live Tutorium/Course Feed

# Internet of Things

**Course Code: DLMBMMIIT01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The internet of things (IoT), once a rough vision, has become reality today in a broad manner. There is a plethora of devices and services available to both consumers and businesses. From smart homes to smart cities, from smart devices to smart factories – internet-of-things technologies impact on our lives and environments. This course follows a top-down approach, discussing a broad set of aspects connected with the internet of things. It starts with use cases and risks from the perspectives of customers and businesses and winds up with a technical foundation of the internet of things. To address the engineering perspective, a set of techniques is proposed.

**Course Outcomes**

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

**Contents**

1. Introduction into the Internet of Things
   - 1.1 Foundations and Motivations
   - 1.2 Potential and Challenges
2. Social and Business Relevance
   - 2.1 Innovations for Consumers and Industry
   - 2.2 Impact on Human and Work Environment
   - 2.3 Privacy and Security

3. Architectures of Internet of Things and Industrial Internet of Things
   - 3.1 Elements of IoTs and IIoTs
   - 3.2 Sensors and Nodes
   - 3.3 Power Systems
   - 3.4 Fog Processors
   - 3.5 Platforms

4. Communication Standards and Technologies
   - 4.1 Network Topologies
   - 4.2 Network Protocols
   - 4.3 Communication Technologies

5. Data Storage and Processing
   - 5.1 NoSQL and MapReduce
   - 5.2 Linked Data and RDF(S)
   - 5.3 Semantic Reasoning
   - 5.4 Complex Event Processing
   - 5.5 Machine Learning
   - 5.6 Overview of Existing Data Storage and Processing Platforms

6. Fields of Application
   - 6.1 Smart Home/Living
   - 6.2 Smart Buildings
   - 6.3 Ambient Assisted Living
   - 6.4 Smart Energy/Grid
   - 6.5 Smart Factory
   - 6.6 Smart Logistics
   - 6.7 Smart Healthcare
   - 6.8 Smart Agriculture

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Lea, P. (2018). Internet of things for architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Birmingham: Packt Publishing Ltd. (Database: Dawson).<br>▪ McEwen, A., & Cassimally, H. (2013). Designing the internet of things. Chichester: John Wiley & Sons. (Database: ProQuest).<br>▪ Raj, P., & Raman, A. C. (2017). The Internet of Things: Enabling technologies, platforms, and use cases. Boca Raton, FL: Auerbach Publications. (Database: ProQuest).<br>▪ Weber, R. H., & Weber, R. (2010). Internet of Things. Heidelberg: Springer. (Database: Dawson). |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** yes<br>**Course Evaluation:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☑ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☑ Shortcast | ☐ Live Tutorium/Course Feed |
| ☑ Audio | |
| ☑ Exam Template | |

# Seminar: Current Topics in Data Science

**Module Code: DLMDSSCTDS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Tim Schlippe (Seminar: Current Topics in Data Science)

**Contributing Courses to Module**

- Seminar: Current Topics in Data Science (DLMDSSCTDS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Fernstudium<br>Written Assessment: Research Essay | |

**Weight of Module**

see curriculum

**Module Contents**

In this module, students will reflect on current developments in data science. To this end, pertinent topics will be introduced via articles, that are then critically evaluated by the students in the form of a written essay.

**Learning Outcomes**

**Seminar: Current Topics in Data Science**

On successful completion, students will be able to

- identify current research trends and topics in data science.
- outline a selected topic in the form of a written essay.
- explain relevant assumptions and design choices pertaining to the topic of choice.
- relate the chosen topic to comparable approaches.
- name and describe potential applications for the chosen topic's concepts.

| **Links to other Modules within the Study Program** | **Links to other Study Programs of IUBH** |
| --- | --- |
| This module is similar to other modules in the fields of Data Science & Artificial Intelligence | All Master Programmes in the IT & Technology fields |

# Seminar: Current Topics in Data Science

**Course Code: DLMDSSCTDS01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 5 | none |

**Course Description**

The theory and applications of data science are constantly evolving, with new models and model variations being proposed at a steady rate. Innovative methodological approaches as well as fresh application possibilities are also being continuously developed. This course aims to familiarize the students with the current trends in this rapidly-changing environment. The students learn to independently analyze selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.

**Course Outcomes**

On successful completion, students will be able to

- identify current research trends and topics in data science.
- outline a selected topic in the form of a written essay.
- explain relevant assumptions and design choices pertaining to the topic of choice.
- relate the chosen topic to comparable approaches.
- name and describe potential applications for the chosen topic's concepts.

**Contents**

- The seminar covers current topics in data science. Each participant must write a seminar paper on a topic assigned to him/her.

**Literature**

**Compulsory Reading**

**Further Reading**


- Bishop, C. M. (2016). Pattern recognition and machine learning. New York, NY: Springer.
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2017). Introduction to statistical learning . New York, NY: Springer.
- Kirk, M. (2017). Thoughtful machine learning with Python. Sebastopol, CA: O'Reilly.
- Kleppmann, M. (2017). Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. Sebastopol, CA: O'Reilly.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Seminar |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** no |
| **Type of Exam** | Written Assessment: Research Essay |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☑ Guideline |
| ☐ Shortcast | ☐ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# 4. Semester

# Master Thesis

**Module Code: MMTHE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | MA | 30 | 900 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Degree Program Advisor (SGL) (Master Thesis) / Degree Program Advisor (SGL) (Colloquium)

**Contributing Courses to Module**

- Master Thesis (MMTHE01)
- Colloquium (MMTHE02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Master Thesis<br>• Study Format "Fernstudium": Masterarbeit (90)<br>Colloquium<br>• Study Format "Fernstudium": Presentation: Colloquium (10) |

**Weight of Module**

see curriculum

**Module Contents**

**Master Thesis**

- Master's thesis

**Colloquium**

- Colloquium on the Master's thesis

**Learning Outcomes**

**Master Thesis**

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- analyse selected tasks with scientific methods, critically evaluate them and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyse existing (research) literature appropriate to the topic of the Master's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

**Colloquium**

On successful completion, students will be able to

- present a problem from their field of study under consideration of academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in the Master's thesis.
- actively answer subject-related questions from subject experts (experts of the Master's thesis).

| Links to other Modules within the Study Program | Links to other Study Programs of IUBH |
|---|---|
| This module is similar to other modules in the field(s) of Methods. | All Master Programmes in the Business & Management field(s). |

# Master Thesis

**Course Code: MMTHE01**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 27 | none |

**Course Description**

The aim and purpose of the Master's thesis is to successfully apply the subject-specific and methodological competencies acquired during the course of study in the form of an academic dissertation with a thematic reference to the major field of study. The content of the Master's thesis can be a practical-empirical or theoretical-scientific problem. Students should prove that they can independently analyse a selected problem with scientific methods, critically evaluate it and work out proposed solutions under the subject-methodological guidance of an academic supervisor. The topic to be chosen by the student from the respective field of study should not only prove the acquired scientific competences, but should also deepen and round off the academic knowledge of the student in order to optimally align his professional abilities and skills with the needs of the future field of activity.

**Course Outcomes**

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- analyse selected tasks with scientific methods, critically evaluate them and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyse existing (research) literature appropriate to the topic of the Master's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

**Contents**

- Within the framework of the Master's thesis, the problem as well as the scientific research goal must be clearly emphasized. The work must reflect the current state of knowledge of the topic to be examined by means of an appropriate literature analysis. The student must prove his ability to use the acquired knowledge theoretically and/or empirically in the form of an independent and problem-solution-oriented application.

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Hunziker, A. W. (2010): Fun at scientific work. This is how you write a good semester, bachelor or master thesis. 4th edition, SKV, Zurich.<br>▪ Wehrlin, U. (2010): Scientific work and writing. Guide to the preparation of Bachelor's theses, Master's theses and dissertations - from research to book publication. AVM, Munich.<br>▪ Selection of literature according to topic |

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Thesis-Kurs |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** yes |
| **Type of Exam** | Masterarbeit |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 810 h | 0 h | 0 h | 0 h | 0 h | 810 h |

| Instructional Methods | |
|---|---|
| ☐ Learning Sprints® | ☐ Review Book |
| ☐ Course Book | ☐ Creative Lab |
| ☐ Vodcast | ☐ Guideline |
| ☐ Shortcast | ☐ Live Tutorium/Course Feed |
| ☐ Audio | |
| ☐ Exam Template | |

# Colloquium

**Course Code: MMTHE02**

| Study Level | Language of Instruction | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| MA | English | | 3 | none |

**Course Description**

The colloquium will take place after submission of the Master's thesis. This is done at the invitation of the experts. During the colloquium, the students must prove that they have fully independently produced the content and results of the written work. The content of the colloquium is a presentation of the most important work contents and research results by the student, and the answering of questions by the experts.

**Course Outcomes**

On successful completion, students will be able to

- present a problem from their field of study under consideration of academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in the Master's thesis.
- actively answer subject-related questions from subject experts (experts of the Master's thesis).

**Contents**

- The colloquium includes a presentation of the most important results of the Master's thesis, followed by the student answering the reviewers' technical questions.

**Literature**

**Compulsory Reading**

**Further Reading**

- Renz, K.-C. (2016): The 1 x 1 of the presentation. For school, study and work. 2nd edition, Springer Gabler, Wiesbaden.

### Study Format Fernstudium

| Study Format | Course Type |
|---|---|
| Fernstudium | Thesis Defense |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **BOLK:** no<br>**Course Evaluation:** yes |
| **Type of Exam** | Presentation: Colloquium |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Presence** | **Tutorial** | **Self Test** | **Practical Experience** | **Hours Total** |
| 90 h | 0 h | 0 h | 0 h | 0 h | 90 h |

**Instructional Methods**

- ☐ Learning Sprints®
- ☐ Course Book
- ☐ Vodcast
- ☐ Shortcast
- ☐ Audio
- ☐ Exam Template
- ☐ Review Book
- ☐ Creative Lab
- ☐ Guideline
- ☐ Live Tutorium/Course Feed