### Content of the courses

**Advanced Software Design Techniques**
- Design Patterns Application and Interaction
- Evolutionary Design Techniques (TDD, BDD, Refactoring)
- Domain Modeling (DDD)
- Components and Modularization
- Framework Development (Extension Points, Reflection, Metadata)
- Software Design Evaluation (Code Metrics, Code Smells, Software Visualization)

**Agile Software Development**
- Origin and evolution of agile software development and modern agile
- Major agile frameworks and hybrid approaches
- Key agile engineering and project management practices
- People-centric and teamwork in agile software development
- Continuous experimentation using agile approaches
- Scaling agile: distributed and/or large agile software development projects

**Cloud Computing and Distributed Systems**
- Virtualisation
- Distributed Systems Algorithms
- Network Technologies
- Cloud Systems
- Storage

**Contemporary Software Development**
- Software development environments
- Configuration management
- Software artifact management
- Design and programming techniques in practice
- Tools and techniques for process management and quality assurance
- Continuous integration

**Design and Development of Business Software**
- Introduction to Business Software
- Modelling business process
- Systems for small/medium business
- Enterprise systems
- Business intelligence dashboards and online analytic processing

**DevOps**
- Unified processes between development and operations
- Value of DevOps and measuring DevOps
- Configuration Management
- Continuous integration and delivery and continuous testing

**Information retrieval**
- Document Indexing
- Vector Space Model
- Web Search
- Text Classification
- Topic Modelling
- Introduction to text mining

**Introduction to parallel computing (cohorts till 2022) Parallel Computing (cohorts from 2023)**
- Introduction to architectures for parallel and distributed systems
- Shared memory model and GPU Computing
- Distributed memory model: introduction to Message Passing Interface
- Principle and design of parallel algorithms
- Selection of parallel algorithms
- Performance Analysis, optimization and tuning

**Entrepreneurial Software Engineering**
- Nature and characteristics of software start-ups
- Problem and solution identification and validation
- Building minimum viable products
- Lean analytics and pivoting
- Continuous retrospectives for start-up team learning
- Scaling software start-ups

**Microcontroller Programming**
- Basic programming syntax and structure in C
- Functions
- Conditional control structures
- Arithmetic, comparison and Boolean operators
- Pointers and addressing
- Data types
- Interrupts
- Simple electronic circuits

**Mobile Robotics**
- Functional architecture of unmanned systems.
- Vehicle dynamics and modeling.
- Common navigation sensors.
- Low-level, control.
- State & disturbance estimation.
- Path generation & waypoint navigation.

**Programmable Logic Controllers**
- Elementary switching theory
- Logical functions and ladder diagrams
- Basic of Programmable Logic Controller (PLC)
- PLC Programming

**Programming and Visualization for Data Science**

**M1: Data Visualization and Exploration**

**M2: Programming for Data Science**
- Languages for programming data and data visualization
- Integrated Development Environments for Data Science
- Exploratory data analytics, data exploration, and feature engineering
- Data wrangling, cleaning, and preprocessing
- Advanced libraries for linear algebra and statistics
- Data science pipelines, from data ingestion to models and analysis
- Model tuning, validation, and testing
- Reproducible analysis practices
- Human perception for effective visualization
- Data types and visual encodings
- Visualization idioms
- Advanced libraries for data visualization

**Research Methods and Technology Transfer**
- Research methods
- Quality assessment of research papers
- Literature Review
- Dissemination techniques for research results
- Research Planning
- Technology transfer

**Robotics**
- An introduction to mechatronics and robotic systems
- An overview of industrial, mobile and service robots
- Robotics: 3D Kinematics and statics
- Direct and inverse kinematics
- Application to industrial manipulators (PUMA, SCARA)
- Differential Kinematics and Statics
- Sensors and actuators for industrial robots and mechatronic systems
- Basis on simulation and programming of robotic systems

**Software and Systems Security**
- Computer Security Technology and Principles
- Data security
- Software and Network Security and Trusted Systems
- Social security
- System Vulnerabilities and Attacks
- Security Management

**Software for Technical Drawing**
- Drawing standards and representation options
- Representation of parts and their peculiarities
- Computer-Aided Design (CAD)
- Managing drawings

**Software Maintenance and Evolution**
- Introduction to software maintenance and evolution
- Software Refactoring
- Mining software repositories
- Machine learning for software engineering
- Using software metrics to assess and monitor the quality of software systems
- Using textual analysis techniques in the context of software maintenance and evolution

**Systems design and implementation**

- **M1: Embedded Systems Design and Implementation**
  - Fundamental notions and architectures of embedded and cyber-physical systems
  - Control and management of time and hardware interfaces
  - Design and programming of real-time software
  - Hardware architectures including MPU/MCUs, DSPs, FPGAs and ASICs
  - Practical aspects of real-world implementation and engineering aspects
  - General Overview, current trends and future applications of XR technologies
  - Introduction to Computer Graphics – The rendering pipeline
  - Working with a graphics engine (e.g. OpenGL, Unity3d)
  - Input devices – controllers, motion trackers and motion capture technologies for tracking
  - Output devices – Head Mounted VR Displays, Augmented and Mixed reality glasses
  - Rapid XR prototyping

- **M2: Extended Reality: Augmented, Virtual and Mixed Reality**
  - Fundamental notions and architectures of embedded and cyber-physical systems
  - Control and management of time and hardware interfaces
  - Design and programming of real-time software
  - Hardware architectures including MPU/MCUs, DSPs, FPGAs and ASICs
  - Practical aspects of real-world implementation and engineering aspects
  - General Overview, current trends and future applications of XR technologies
  - Introduction to Computer Graphics – The rendering pipeline
  - Working with a graphics engine (e.g. OpenGL, Unity3d)
  - Input devices – controllers, motion trackers and motion capture technologies for tracking
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  - Rapid XR prototyping

**Verification and Reliability for Dependable Systems**
- Dependable properties of systems
- Software and software systems testing
- Techniques for verification of software systems
- Advances in test design and implementation
- Search Based testing
- HW and SW reliability models

**Selected topics: Infobytes (Topics can change)**
- Introduction to robotics
- Digitalization of production processes – Industry 4.0
- Basic of cyber-physical systems