System Test Engineering

2. Semester

Subject to Approval by the Relevant Bodies

Course	Type	THW	ECTS
Radio Frequency Engineering	IC	4	7
Machine Learning and Optimization	IC	3	6
Test and Measurement Automation	IC	5	8
Test Standards and Quality Management	LE	2	3
Software Quality and Security	IC	4	6
		18	**30**

IC Integrated course

LE Lecture

THW Hours per week

ECTS European Credit Transfer and Accumulation System

Radio Frequency Engineering 4 SWS/7 ECTS

Teaching Content

- Introduction: Electrodynamics, Maxwell's equations
- Transmission line theory: telegraph equation, time-independent wave-equation, voltage- and current-waves on lossless transmission lines, characteristic impedance, wavelength, phase velocity, reflection coefficient, VSWR, matching, Smith chart, S-parameters microstrip lines, impedance matching networks
- Electromagnetic waves: plane waves in vacuum, plane waves in linear media (skin effect, eddy current, proximity effect, displacement current), electromagnetic waves in wave guides
- Antennas and antenna arrays: Hertz antenna (properties of the electromagnetic field, far-field), linear radiators, antenna arrays
- RF Components: baluns, directional couplers, power divider, circulator, double balanced mixers

Competence Acquisition

After finishing this course, students can

- an explain the mechanism of wave propagation on conductors,
- are able to calculate characteristic impedance, reflection factor and impedance of conducted waves,
- can explain the effects in the quasi-stationary field (skin and proximity effect) and can calculate the penetration depth and the increase in resistance,
- can explain the mechanism of the propagation of electromagnetic waves,
- can calculate the characteristic impedance, reflection factor and velocity of electromagnetic waves in free space and in media,
- can explain the operation principles of RF components and their application,
- can explain the basic operation of antennas,
- can design matching networks, and
- can operate high-frequency measuring devices and carry out measurements with them.

Machine Learning and Optimization 3 SWS/6 ECTS

Teaching Content

- General concepts, algorithms, and models in machine learning such as constrained and unconstrained optimization, cross-validation, and model overfitting and underfitting.
- Data preparation techniques such as handling missing values and outliers, transforming data, binning, and encoding categorical variables
- Selection and application of appropriate machine learning models for clustering, classification, and regression
- Metrics-dependent model evaluation and model deployment into existing systems or processes

Competence Acquisition

After finishing this course, students can

- identify and articulate the key steps in the machine learning process and address their associated challenges,
- apply key algorithms for both constrained and unconstrained optimization to various problem sets,
- implement techniques to prevent overfitting and underfitting in machine learning models,
- select and use appropriate clustering and classification methods to categorize data effectively, and
- construct both shallow and deep neural networks and apply them to real-world data sets for predictive modelling, given appropriate Python knowledge and practice.

Test and Measurement Automation 5 SWS/8 ECTS

Teaching Content

- Introduction to test and measurement automation with focus on semiconductor industry: automated test equipment and virtual instrumentation software
- Measurement instruments: terminology, key specification parameters, interpretation of datasheets for power supplies, source measure units, digital multimeters, function generators, oscilloscopes
- Standard interfaces of measurement/testing systems
- Selection of hardware and software based on test cases and their measurement requirements
- Development of communication between the system and the necessary device drivers and libraries
- Design and implementation of an automated test system for an example DUT including software, measurement and testing equipment as well as hardware (sensors, PCB)
- Development of a proper datalogging strategy to post-process raw data for analysing measurement results
- Apply version control methodologies to developed measurements, results and reports

Competence Acquisition

After finishing this course, students can

- can select appropriate instruments for a given test case based on the instrument specifications,
- can name and identify key instrument specification parameters,
- can review and interpret datasheets of integrated circuits,
- can define automated measurement setups for a given scenario by creating a block diagram that illustrates the instruments and the appropriate connection to the Device Under Test (DUT) including the communication interfaces,
- are able to create automated measurements based on manual workflows, and
- are able to use version control systems such as git to track changes of their source code, measurement results, measurement reports and measurement setups.

Test Standards and Quality Management 2 SWS/3 ECTS

Teaching Content

- Quality standards such as IATF 16949, ISO 9000, ISO 9001
- Issue and risk management
- Traceability and product liability
- Toyota production system (continuous improvement, Kaizen, 5S, ...)
- Test quality (KPI's, Economics, error prevention, error handling)
- Reliability stress tests (e.g. HTOL, HAST, THB, TC)
- Statistical test methods and the ISO 2859 standard
- EMC: Introduction and overview, fundamentals and theory, Integrated circuits test methods

Competence Acquisition

After finishing this course, students can

- explain of the fundamentals of the ISO9000 family,
- handle a common quality management system by using quality management tools,
- apply continuous improvement,
- interpret and apply reliability stress tests,
- interpret and apply test quality indicator and handle test economics,
- research the relevant standards for specific problems and apply them, and
- interpret common EMC standards.

Software Quality and Security 4 SWS/6 ECTS

Teaching Content

- Software Inspection: This process includes examining source code to identify "Bad Smells", applying software metrics for code quality assessment, and using static code analysis to detect potential bugs
- Software testing: It encompasses unit tests, which target individual software components, and integration tests, which validate interactions between components to ensure seamless functionality
- Secure coding: This includes programming techniques like encapsulation, input validation, output encoding, secure data representation, and robust error handling & logging
- Cryptography in practice: It focuses on cryptographic techniques to secure data at rest, protecting sensitive information from unauthorized access and ensuring data integrity
- Reverse engineering: This involves analysis of binaries to understand their structure and functionality which is commonly used in debugging and security research

Competence Acquisition

After finishing this course, students can

- perform manual and tool-based inspections of software systems to locate errors and code smells,
- design and implement unit- and integration test cases,
- master the most important techniques of secure coding and can therefore identify and remove security gaps in the source code,
- apply and configure the selected cryptographic algorithms, and
- master the technique of reverse engineering binary files to check for vulnerabilities or malware.