Complete Catalogue of all modules
FB 18 Electrical Engineering and Information Technology

Module manual
Date: 01.09.2017
# Contents

1 Bachelor

1.1 Lecture .......................................................... 1
   Analog Integrated Circuit Design .................................. 1
   Deterministic Signals and Systems .................................. 2
   Power Systems I ....................................................... 4
   Electrical Machines and Drives ...................................... 5
   Electromechanical Systems I ......................................... 6
   Electronics .......................................................... 7
   Electrical Engineering and Information Technology I ............. 9
   Electrical Engineering and Information Technology II ........... 10
   Electrical Power Engineering ......................................... 12
   Introduction to Electrodynamics .................................... 14
   Fundamentals of Signal Processing .................................. 15
   Microelectronic Devices .............................................. 17
   Microwave Engineering I ............................................. 19
   High Voltage Technology I ........................................... 20
   Information Theory I ................................................ 21
   Communication Networks I ............................................ 22
   Communication Technology I .......................................... 24
   Power Electronics .................................................... 25
   Logic Design ........................................................ 27
   Measuring Technique ................................................ 28
   Fundamentals of Communication ..................................... 30
   Optical Communications I – Components .......................... 32
   Photonic I - Basics and Applications ............................... 34
   Programming in Automatic Control (C/C++) ........................ 35
   Computer Systems I ................................................... 36
   Software Engineering - Introduction ................................ 37
   System Dynamics and Control Systems I ........................... 38
   System Dynamics and Automatic Control Systems II ............. 40
   Technical Electrodynamics .......................................... 41
   Technology of Micro- and Precision Engineering ................. 42
   Computational Electromagnetics and Applications I ............. 43
   Reliability of Electronic Devices and Materials used in Microelectronics ................................................... 44

1.2 Internships ......................................................... 46
   C/C++ Programming Lab .............................................. 46
   Electronics ........................................................ 47
   HDL Lab ........................................................... 49
   Mechatronics Workshop .............................................. 50
   Measuring Technique ................................................ 51
   Actuators for Mechatronic Systems Lab ............................. 53
   Electrical Engineering and Information Technology Lab I ........ 54
   Laboratory Matlab/Simulink I ...................................... 56
   Multimedia Communications Lab I ................................... 57
   Laboratory Course Control of Mechatronic Systems ............... 59
   Laboratory Control Engineering I ................................... 60
   Software Lab ........................................................ 61
   Software Lab Computational Electromagnetics and Applications I ................................................... 62
1.3 Seminars .......................................................... 63
   Photonic I - Basics and Applications .......................... 63
   Seminar Electronic Circuits .................................... 64
   Seminar Terahertz Components & Applications .............. 65
1.4 Introductory Seminar Courses ................................. 66
   Proseminar Electrical Engineering and Information Technology ........ 66
   Proseminar Electrical Engineering and Information Technology ........ 67
   Proseminar Electrical Engineering and Information Technology ........ 68
   Proseminar Electrical Engineering and Information Technology ........ 69
   Proseminar Electrical Engineering and Information Technology ........ 70
   Proseminar Electrical Engineering and Information Technology ........ 71
   Proseminar Electrical Engineering and Information Technology ........ 72
   Proseminar Electrical Engineering and Information Technology ........ 73
   Proseminar Electrical Engineering and Information Technology ........ 74
   Proseminar Electrical Engineering and Information Technology ........ 75
   Proseminar Electrical Engineering and Information Technology ........ 76
   Proseminar Electrical Engineering and Information Technology ........ 77
   Proseminar Electrical Engineering and Information Technology ........ 78
   Proseminar Electrical Engineering and Information Technology ........ 79
   Proseminar Electrical Engineering and Information Technology ........ 80
   Proseminar Electrical Engineering and Information Technology ........ 81
   Proseminar Electrical Engineering and Information Technology ........ 82
   Proseminar Electrical Engineering and Information Technology ........ 83
   Proseminar Electrical Engineering and Information Technology ........ 84
   Proseminar ETIT Option MPE .................................. 85
   Proseminar Electrical Engineering and Information Technology ........ 86
1.5 Project Seminars ............................................... 87
   Project Development Methodology I ............................ 87
   Project Seminar Particle Accelerator Technology ................ 88
   Project Seminar Electromagnetic CAD .......................... 89
   Project Seminar Integrated Electronic Systems ................. 90
   Project Seminar Communication and Sensor Systems ............ 91
   Project Seminar Communication and Sensor Systems ............ 92
   Project Seminar Communication and Sensor Systems ............ 93
   Project Seminar Communication and Sensor Systems ............ 94
   Project Seminar Communication and Sensor Systems ............ 95
   Project Seminar Communication and Sensor Systems ............ 96
   Multimedia Communications Project I .......................... 97
   Project Seminar Telecommunications ............................ 99
   Project Seminar Telecommunications ............................ 100
   Project Seminar Telecommunications ............................ 101
   Project Seminar Telecommunications ............................ 102
   Project Seminar Telecommunications ............................ 103
   Project Seminar Computer Systems ............................. 104
   Project Seminar Software Systems .............................. 105
   Project Seminar Terahertz Systems & Applications ............. 106
1.6 Project ......................................................... 107
   Subject-Advisor Introductionary Project ......................... 107
   Subject-Advisor Introductionary Project ......................... 107
   Subject-Advisor Introductionary Project ......................... 108
   Subject-Advisor Introductionary Project ......................... 109
1.7 Field Trip .................................................... 110
   Excursion MPE ................................................ 110
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Lecture</td>
<td>111</td>
</tr>
<tr>
<td>Adaptive Filters</td>
<td>111</td>
</tr>
<tr>
<td>Advanced Digital Integrated Circuit Design</td>
<td>113</td>
</tr>
<tr>
<td>Advanced Power Electronics</td>
<td>114</td>
</tr>
<tr>
<td>Advances in Digital Signal Processing: Imaging and Image Processing</td>
<td>116</td>
</tr>
<tr>
<td>Acoustics I</td>
<td>118</td>
</tr>
<tr>
<td>Applied Superconductivity</td>
<td>119</td>
</tr>
<tr>
<td>Antennas and Adaptive Beamforming</td>
<td>120</td>
</tr>
<tr>
<td>Accelerator Physics</td>
<td>122</td>
</tr>
<tr>
<td>Acceleration of Charged Particles in Electromagnetic Fields</td>
<td>123</td>
</tr>
<tr>
<td>Computer Vision in Engineering</td>
<td>124</td>
</tr>
<tr>
<td>Biomedical Technology</td>
<td>126</td>
</tr>
<tr>
<td>Circuit Building Blocks for Communication Systems</td>
<td>127</td>
</tr>
<tr>
<td>Communication Technology II</td>
<td>128</td>
</tr>
<tr>
<td>Complex Network Dynamics: Theory and Applications</td>
<td>129</td>
</tr>
<tr>
<td>Computational Methods for Systems and Synthetic Biology</td>
<td>130</td>
</tr>
<tr>
<td>Computer Aided Design for SoCs</td>
<td>132</td>
</tr>
<tr>
<td>Content Networking</td>
<td>133</td>
</tr>
<tr>
<td>Control of Drives</td>
<td>134</td>
</tr>
<tr>
<td>Digital Control Systems I</td>
<td>136</td>
</tr>
<tr>
<td>Digital Control Systems II</td>
<td>137</td>
</tr>
<tr>
<td>Digital Signal Processing</td>
<td>138</td>
</tr>
<tr>
<td>Real Time Applications and Communication with Microcontrollers and programmable Logic Devices</td>
<td>139</td>
</tr>
<tr>
<td>Real-Time Systems</td>
<td>141</td>
</tr>
<tr>
<td>Electric Railways</td>
<td>142</td>
</tr>
<tr>
<td>Power Systems II</td>
<td>143</td>
</tr>
<tr>
<td>Power Systems III</td>
<td>144</td>
</tr>
<tr>
<td>Electromagnetic Compatibility</td>
<td>145</td>
</tr>
<tr>
<td>Electronic Sensors</td>
<td>146</td>
</tr>
<tr>
<td>Electrothermal Processes</td>
<td>148</td>
</tr>
<tr>
<td>Power Cable Systems</td>
<td>149</td>
</tr>
<tr>
<td>Regulation of Power Supply</td>
<td>150</td>
</tr>
<tr>
<td>Energy Converters - CAD and System Dynamics</td>
<td>151</td>
</tr>
<tr>
<td>Evolutionary Systems - From Biology to Technology</td>
<td>153</td>
</tr>
<tr>
<td>Fuzzy Logic, Neural Networks and Evolutionary Algorithms</td>
<td>154</td>
</tr>
<tr>
<td>Large Generators and High Power Drives</td>
<td>155</td>
</tr>
<tr>
<td>Railway Vehicle Engineering</td>
<td>156</td>
</tr>
<tr>
<td>High-Level Synthesis</td>
<td>157</td>
</tr>
<tr>
<td>Microwave Engineering II</td>
<td>158</td>
</tr>
<tr>
<td>High Voltage Switchgear and Substations</td>
<td>159</td>
</tr>
<tr>
<td>High Voltage Technology II</td>
<td>160</td>
</tr>
<tr>
<td>Identification of Dynamic Systems</td>
<td>162</td>
</tr>
<tr>
<td>Industrial Electronics</td>
<td>164</td>
</tr>
<tr>
<td>Information Theory II</td>
<td>165</td>
</tr>
<tr>
<td>Communication Networks II</td>
<td>166</td>
</tr>
<tr>
<td>Communication Networks IV</td>
<td>168</td>
</tr>
<tr>
<td>Convex Optimization in Signal Processing and Communications</td>
<td>170</td>
</tr>
<tr>
<td>Power Plants and Renewable Energies</td>
<td>171</td>
</tr>
<tr>
<td>Lighting Technology I</td>
<td>172</td>
</tr>
<tr>
<td>Lighting Technology II</td>
<td>173</td>
</tr>
<tr>
<td>Low-Level Synthese</td>
<td>174</td>
</tr>
<tr>
<td>Controller Design for Multivariable Systems in State Space</td>
<td>175</td>
</tr>
<tr>
<td>High Voltage Measuring Techniques</td>
<td>176</td>
</tr>
<tr>
<td>Microprocessor Systems</td>
<td>178</td>
</tr>
<tr>
<td>Micro Actuators and Small Motors</td>
<td>179</td>
</tr>
<tr>
<td>Course Name</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Advanced Integrated Circuit Design Lab</td>
<td>195</td>
</tr>
<tr>
<td>Practical Training with Drives</td>
<td>196</td>
</tr>
<tr>
<td>Power Laboratory I</td>
<td>197</td>
</tr>
<tr>
<td>Power Laboratory II</td>
<td>198</td>
</tr>
<tr>
<td>Lighting Technology I</td>
<td>199</td>
</tr>
<tr>
<td>Lighting Technology II</td>
<td>200</td>
</tr>
<tr>
<td>Microwave Measurement Technologies</td>
<td>201</td>
</tr>
<tr>
<td>Computer Systems II</td>
<td>202</td>
</tr>
<tr>
<td>Robust Control</td>
<td>203</td>
</tr>
<tr>
<td>X-Ray Free Electron Lasers</td>
<td>204</td>
</tr>
<tr>
<td>Fast Boundary Element Methods for Engineers</td>
<td>205</td>
</tr>
<tr>
<td>Sensor Array Processing and Adaptive Beamforming</td>
<td>206</td>
</tr>
<tr>
<td>Sensor Signal Processing</td>
<td>207</td>
</tr>
<tr>
<td>Sensor Technique</td>
<td>208</td>
</tr>
<tr>
<td>Simulation and Modelling Techniques and Tools for Mobile Communication Systems</td>
<td>209</td>
</tr>
<tr>
<td>Social Learning and Knowledge Sharing Technologies</td>
<td>210</td>
</tr>
<tr>
<td>Software Defined Networking</td>
<td>211</td>
</tr>
<tr>
<td>Software-Engineering - Maintenance and Quality Assurance</td>
<td>212</td>
</tr>
<tr>
<td>Software Product Lines – Concepts, Analysis and Implementation</td>
<td>213</td>
</tr>
<tr>
<td>Speech and Audio Signal Processing</td>
<td>214</td>
</tr>
<tr>
<td>System Dynamics and Automatic Control Systems III</td>
<td>215</td>
</tr>
<tr>
<td>Technology of Microsystems Technology</td>
<td>216</td>
</tr>
<tr>
<td>Ultra-Large Scale Integration Technology</td>
<td>217</td>
</tr>
<tr>
<td>Terahertz Systems and Applications</td>
<td>218</td>
</tr>
<tr>
<td>Terrestrial and Satellite-based Radio Systems</td>
<td>219</td>
</tr>
<tr>
<td>Overvoltage Protection and Insulation Coordination in Power System</td>
<td>220</td>
</tr>
<tr>
<td>Computational Electromagnetics and Applications II</td>
<td>221</td>
</tr>
<tr>
<td>Computational Electromagnetics and Applications III</td>
<td>222</td>
</tr>
<tr>
<td>Simulation of beam dynamics and electromagnetic fields in accelerators</td>
<td>223</td>
</tr>
<tr>
<td>Energy Management and Optimization</td>
<td>224</td>
</tr>
<tr>
<td>Machine Learning &amp; Energy</td>
<td>225</td>
</tr>
<tr>
<td>Machine Learning in Information and Communication Technology (ICT)</td>
<td>226</td>
</tr>
<tr>
<td>2.2 Internships</td>
<td>227</td>
</tr>
<tr>
<td>Advanced Integrated Circuit Design Lab</td>
<td>228</td>
</tr>
<tr>
<td>Practical Training with Drives</td>
<td>229</td>
</tr>
<tr>
<td>Power Laboratory I</td>
<td>230</td>
</tr>
<tr>
<td>Power Laboratory II</td>
<td>231</td>
</tr>
<tr>
<td>Lighting Technology I</td>
<td>232</td>
</tr>
<tr>
<td>Lighting Technology II</td>
<td>233</td>
</tr>
<tr>
<td>Microwave Measurement Technologies</td>
<td>234</td>
</tr>
<tr>
<td>Digital Signal Processing Lab</td>
<td>235</td>
</tr>
<tr>
<td>Electromechanical Systems Lab</td>
<td>236</td>
</tr>
<tr>
<td>Laboratory Communication and Sensor Systems</td>
<td>237</td>
</tr>
<tr>
<td>Laboratory Matlab/Simulink II</td>
<td>238</td>
</tr>
<tr>
<td>Multimedia Communications Lab II</td>
<td>239</td>
</tr>
<tr>
<td>Laboratory Control Engineering II</td>
<td>240</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.3 Seminars</td>
<td></td>
</tr>
<tr>
<td>Advanced Topics in Statistical Signal Processing</td>
<td>251</td>
</tr>
<tr>
<td>Application, Simulation and Control of Power Electronic Systems</td>
<td>252</td>
</tr>
<tr>
<td>Calculation of Transients in Electrical Power Systems</td>
<td>253</td>
</tr>
<tr>
<td>Computational Modeling for the IGEM Competition</td>
<td>254</td>
</tr>
<tr>
<td>Future Electrical Power Supply</td>
<td>255</td>
</tr>
<tr>
<td>European Microwave School</td>
<td>256</td>
</tr>
<tr>
<td>International Summer School 'Microwaves and Lightwaves'</td>
<td>257</td>
</tr>
<tr>
<td>Design of Electrical Machines and Actuators with Numerical Field Calculation</td>
<td>258</td>
</tr>
<tr>
<td>Optical Communications 3 – Seminar WDM Lab</td>
<td>259</td>
</tr>
<tr>
<td>Planning and Application of Electrical Drives (Drives for Electric Vehicles)</td>
<td>260</td>
</tr>
<tr>
<td>Key skills with a focus on language</td>
<td>261</td>
</tr>
<tr>
<td>Seminar Integrated Electronic Systems Design A</td>
<td>263</td>
</tr>
<tr>
<td>Multimedia Communications Seminar I</td>
<td>264</td>
</tr>
<tr>
<td>Multimedia Communications Seminar II</td>
<td>265</td>
</tr>
<tr>
<td>Accelerator Physics and Technology</td>
<td>266</td>
</tr>
<tr>
<td>Seminar Software System Technology</td>
<td>267</td>
</tr>
<tr>
<td>Seminar on Special Topics of Optical Communications</td>
<td>268</td>
</tr>
<tr>
<td>Seminar: Integrated Electronic Systems Design B</td>
<td>269</td>
</tr>
<tr>
<td>Signal Detection and Parameter Estimation</td>
<td>270</td>
</tr>
<tr>
<td>Advanced seminar Microsystem Technology</td>
<td>272</td>
</tr>
<tr>
<td>2.4 Introductory Seminar Courses</td>
<td></td>
</tr>
<tr>
<td>Selected Chapters from Measuring and Sensor Technique</td>
<td>273</td>
</tr>
<tr>
<td>2.5 Project Seminars</td>
<td></td>
</tr>
<tr>
<td>Science in Practice I</td>
<td>274</td>
</tr>
<tr>
<td>Science in Practice II</td>
<td>275</td>
</tr>
<tr>
<td>Advanced Topics in Micro- and Nano Electronics</td>
<td>276</td>
</tr>
<tr>
<td>Product Development Methodology III</td>
<td>277</td>
</tr>
<tr>
<td>Product Development Methodology IV</td>
<td>278</td>
</tr>
<tr>
<td>Project Seminar Advanced µWave Components &amp; Antennas</td>
<td>279</td>
</tr>
<tr>
<td>Project Seminar Wireless Communications</td>
<td>280</td>
</tr>
<tr>
<td>Projekt Seminar Advanced Algorithms for Smart Antenna Systems</td>
<td>281</td>
</tr>
<tr>
<td>Projekt Seminar Procedures for Massive MIMO and 5G</td>
<td>282</td>
</tr>
<tr>
<td>Project Seminar Application in High-Voltage Technology</td>
<td>283</td>
</tr>
<tr>
<td>Project Seminar Automatic Control Systems</td>
<td>284</td>
</tr>
<tr>
<td>Project Seminar Design for Testability</td>
<td>285</td>
</tr>
<tr>
<td>Real-Time System Development Lab</td>
<td>286</td>
</tr>
<tr>
<td>Energy Converters and Electric Drives</td>
<td>287</td>
</tr>
<tr>
<td>Project seminar Applications of Lighting Engineering</td>
<td>288</td>
</tr>
<tr>
<td>Project Course Automotive Mechatronics</td>
<td>289</td>
</tr>
<tr>
<td>Project Seminar MFT</td>
<td>290</td>
</tr>
<tr>
<td>Model-Based Software Development Lab</td>
<td>291</td>
</tr>
<tr>
<td>Multimedia Communications Project Seminar II</td>
<td>292</td>
</tr>
<tr>
<td>Project Course Practical Application of Mechatronics</td>
<td>294</td>
</tr>
<tr>
<td>Project Course Control Engineering</td>
<td>295</td>
</tr>
<tr>
<td>Project Course Automotive Control Engineering</td>
<td>296</td>
</tr>
<tr>
<td>Projektseminar Rekonfigurable Systems</td>
<td>297</td>
</tr>
<tr>
<td>Project Seminar Robotics and Computational Intelligence</td>
<td>298</td>
</tr>
<tr>
<td>2.6 Research Seminar</td>
<td></td>
</tr>
<tr>
<td>Research Seminar “Advanced Methods in Control Theory”</td>
<td>299</td>
</tr>
<tr>
<td>2.7 Field Trip</td>
<td></td>
</tr>
<tr>
<td>Railway Vehicle Engineering</td>
<td>300</td>
</tr>
</tbody>
</table>
## Contents

### 2.8 Colloquies
- Industrial Colloquium ................................................................. 301

### 3 Interdisciplinary Modules of FB 18 .................................................. 302
- Management for Engineers .............................................................. 302
- Standardization, Testing and Approvals in the Electrotechnical Area .... 303
- Patents – How to protect technical inventions ..................................... 305
- What is behind all this? .................................................................... 307
- What is behind all this? .................................................................... 308
1 Bachelor

1.1 Lecture

<table>
<thead>
<tr>
<th>Module name</th>
<th>Analog Integrated Circuit Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-ho-1020</td>
</tr>
<tr>
<td>Credit Points</td>
<td>6 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Self study</td>
<td>120 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

1 Content
Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators

2 Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog properties of digital logic gates

3 Recommended prerequisite for participation
Lecture “Electronics”

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE

7 References
Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1020-vl</td>
<td>Analog Integrated Circuit Design</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
<tr>
<td>Type</td>
<td>Lecture</td>
</tr>
<tr>
<td>SWS</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1020-ue</td>
<td>Analog Integrated Circuit Design</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
<tr>
<td>Type</td>
<td>Practice</td>
</tr>
<tr>
<td>SWS</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Deterministic Signals and Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1010</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Anja Klein

1 Content
Fourier Series: Motivation; Fourier series with real coefficients; Fourier series with complex coefficients; examples and applications
Fourier Transform: Motivation - Derviation from Fourier series - Dirichlet conditions - delta function - step function - properties of F-transform - special cases - examples and applications - transmissions systems - expansion into partial fractions
Convolution: Time invariant systems - convolution in frequency domain - Parseval's theorem - properties - examples and applications
Systems and Signals: Bandlimited and time limited systems - systems with only one energy store - examples and applications
Laplace Transform: Motivation - single sided L-transform - inverse L-transform - theorems of L-transform - examples and applications
Linear differential equations: Time invariant systems - rules - general differentiation - linear passive electrical networks - equivalent circuits for passive electrical elements - examples and applications
z-Transform: motivation - sampling - numerical order - definition - examples - transfer function - sampling theorem - examples and applications
Discrete Fourier Transform: motivation, derivation sampling, examples and applications

2 Learning objectives / Learning Outcomes
The student should understand the principles of integral transformations. He should apply them for the solution of physical problems. The techniques of this lecture are essential tools which will be needed in many follow-up lectures and exercises.

3 Recommended prerequisite for participation
Elektrotechnik und Informationstechnik I und Elektrotechnik und Informationstechnik II

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST

7 References
A script of the lecture or slides respectively, will be provided in electronic form.
Basic Literature:
Wolfgang Preuss, “Funktionaltransformationen”, Carl Hanser Verlag, 2002; Klaus-Eberhard Krueger ”Transformationen”, Vieweg Verlag, 2002;
T. Frey, M. Bossert, Signal- und Systemtheorie, Teubner Verlag, 2004
Further Literature:
Dieter Mueller-Wichards "Transformationen und Signale", Teubner Verlag, 1999
Exercises:
Hwei Hsu "Signals and Systems", Schaum's Outlines, 1995

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1010-vl</td>
<td>Deterministic Signals and Systems</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-kl-1010-ue</td>
<td>Deterministic Signals and Systems</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Power Systems I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-1010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jutta Hanson

1 Content
Three-phase network and symmetrical components; overhead lines; cables; transformers; calculation of short-circuit currents; switch equipment; switchgears

2 Learning objectives / Learning Outcomes
The education goals are
- Presentation of components of power system
- Functional elaboration of equipment
- Calculation of the component rating
- Impact on the electrical power system

3 Recommended prerequisite for participation
Contents of the lecture Electrical Power Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc/MSc WI-ET, BSc EPE, BSc/MSc CE, BSc/MSc iST, MSc Informatik

7 References
Script, lecture slides, guiding questions, exercises

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-1010-vl</td>
<td>Power Systems I</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-1010-ue</td>
<td>Power Systems I</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson

1.1 Lecture
Module name
Electrical Machines and Drives

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1020</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

1 Content
Construction and function of induction machine, synchronous machine, direct current machine. Electromagnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version.

2 Learning objectives / Learning Outcomes
With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to:

- calculate and explain the stationary operation performance of the three basic types of electric machine in motor and generator mode,
- understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,
- understand and explain the function and physical background of the components of electrical machines
- understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines.

3 Recommended prerequisite for participation
Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc/MSc Wi-ETiT, BEd

7 References
Detailed textbook and collection of exercises; Complete set of PowerPoint presentations
L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972
S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995
R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1020-vl</td>
<td>Electrical Machines and Drives</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-bi-1020-ue</td>
<td>Electrical Machines and Drives</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>

1.1 Lecture
Module name
Electromechanical Systems I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-wy-1020</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. Roland Werthschützky

1 Content
Structure and design methods of elektromechanical systems, mechanical, acoustical and thermal networks, transducers between mechanical and acoustical networks. Design and devices of electromechanical transducers.

2 Learning objectives / Learning Outcomes
Comprehension, description, calculation and application of the most relevant electromechanical transducers, comprising electrostatic transducer (e.g. microphone and accelerometer), piezoelectric transducers (e.g. micro motors, micro sensors), electrodynamic transducer (loudspeaker, shaker), piezomagnetic transducer (e.g. ultrasonic source). Design of complex electromechanical systems like sensors and actuators and their applications by applying the discrete element network method.

3 Recommended prerequisite for participation
Electrical Engineering and Information Technology I

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc WI-ETiT, MSc MEC

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-wy-1020-vl</td>
<td>Electromechanical Systems I</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Roland Werthschützky</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-wy-1020-ue</td>
<td>Electromechanical Systems I</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Roland Werthschützky</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Electronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1011</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1 Content
18-ho-1011-vl bzw. –ue:
Semiconductor Elements: Diode, MOSFET, Bipolartransistor. Electronic Circuit Design; Basic Analog Circuits and their properties, Behavior and properties of operational amplifiers, circuit simulation with SPICE, small signal amplification, single stage amplifiers, frequency response; digital circuits: CMOS-logic

18-ho-1011-pr:
Practical experiments in the fields:
- digital circuits: FPGA-programming
- analog circuits: basic building blocks, amplifiers, operational amplifiers, filters and demodulators

2 Learning objectives / Learning Outcomes
A student is after successful attending the lecture able to
- analyse the behavior of diodes, MOS- and Bipolartransistors in simple circuits,
- assess the properties of single-transistor amplifiers (MOSFET and BJT), such as small signal behavior, input- and output-resistance;
- design inverting and non-inverting operational amplifiers with passive components and knows the ideal and non-ideal properties;
- calculate the frequency response of simple transistor circuits;
- knows the different circuit techniques (CMOS, NMOS) of logical gates and knows the basic functions (inverter, NAND, NOR).

A student is after successful attending the lab able to
- perform measurements in time and frequency domain using an oscilloscope on simple operational amplifiers;
- design and realize a traffic light controller based on a finite state machine using a FPGA as the target implementation;
- mount passive and active components on a PCB (including preparation of components, soldering) and put the system to function,
- simulate a circuit (filter) using SPICE and perform measurements on the realization.

3 Recommended prerequisite for participation
Basics of Electrical Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)
Module accompanying exam:
- [18-ho-1011-pr] (Study achievements, Optional, Standard BWS)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 4)
Module accompanying exam:
- [18-ho-1011-pr] (Study achievements, Optional, weighting: 3)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc iST, BEd

7 References
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1011-vl</td>
<td>Electronics</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-ho-1011-pr</td>
<td>Electronics Lab</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>18-ho-1011-ue</td>
<td>Electronics</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Electrical Engineering and Information Technology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1070</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

1 **Content**
Units and Equations: Unit systems, equation writing.
Basic definitions: Charge, current, voltage, resistance, energy and power.
Currents and voltages in electrical circuits: Ohmic law, node and mesh equations, parallel and series connections, current and voltage measurement, linear and nonlinear elements, superposition method, star-delta-transformation, node and mesh analysis in linear circuits, controlled sources.
AC systems: Time-dependent currents and voltages, steady-state mode sinusoidal currents and voltages in linear RLC-circuits, resonances in RLC circuits, AC power, transformer.

2 **Learning objectives / Learning Outcomes**
Students will be able after visiting this lecture
- to utilize the basic equations in electrical engineering,
- to determine the currents and voltages in linear and nonlinear circuits,
- to analyze DC and AC systems,
- to calculate simple filter circuits,
- to apply the complex calculation in electrical AC systems.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 **Usability of this module**
BSc. ETiT, BSc iST, BSc MEC, BSc. Wi-ETiT, BSc CE, LA Physik/Mathematik

7 **References**
Frohne, H. u.a. Moeller Grundlagen der Elektrotechnik
Clausert, H. u.a. Grundgebiete der Elektrotechnik 1 + 2

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1070-vl</td>
<td>Electrical Engineering and Information Technology I</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Franko Küppers

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1070-ue</td>
<td>Electrical Engineering and Information Technology I</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Franko Küppers

1.1 Lecture
Module name
Electrical Engineering and Information Technology II

Module Nr. 18-gt-1020
Credit Points 7 CP
Workload 210 h
Self study 135 h
Duration 1
Cycle offered SoSe

Language
German

Module owner
Prof. Dr.-Ing. Gerd Griepentrog

1 Content
Electrostatic fields; stationary electrical flow fields; stationary magnetic fields; temporally variable magnetic fields; capacitor networks, transmission lines

2 Learning objectives / Learning Outcomes
The students have detached themselves from the conception that all electrical procedures are line-bound; they have a clear idea of the field term, can read and interpret field plots and also design simple field plots themselves; they understand the difference between a curl and a divergence field, can describe this difference mathematically and are able to recognize the field type from a mathematical description, respectively; they are able to calculate field distributions for simple rotationally symmetric arrangements analytically; they can deal surely with the definitions of the electrostatic, the electrical quasi-static, the magnetostatic and the magneto-electric field; they have recognized the connection and dualism of electricity and magnetism; they control the mathematical apparatus necessary for their description and can apply it to simple examples; they can calculate with nonlinear magnetic circuits; they can compute inductance, capacity and resistance of simple geometrical arrangements and understand them now as physical characteristics of the respective arrangement; they have recognized, how different forms of energy can be transferred into each other and are thereby already able to solve simple scientific engineering problems; they have understood the underlying physical backgrounds for many applications of electrical engineering and are able to describe them mathematically, develop it further in a simple way and apply it to other examples; they are familiar with the system of Maxwell's equations and can transfer them from the integral into the differential form; they have a first idea of the importance of Maxwell's equations for all conceptual formulations of electrical engineering and they understand the propagation of electromagnetic waves in the free space and on transmission lines

3 Recommended prerequisite for participation
Electrical Engineering and Information Technology I

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST

7 References
• Downloadable slides

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1020-vl</td>
<td>Electrical Engineering and Information Technology II</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

1.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1020-ue</td>
<td>Electrical Engineering and Information Technology II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Electrical Power Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

1 Content
The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.
First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.
Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.
The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications.
The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

2 Learning objectives / Learning Outcomes
Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.
They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.
They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.
They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

3 Recommended prerequisite for participation
Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 Usability of this module

1.1 Lecture
### References
Lecture notes (slides)
Practice documents (examples, solutions)
Additional and more detailed literature:
- Rummich: Energiespeicher, expert-verlag, Rennningen, 2015, 2. Aufl.;

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1010-vl</td>
<td>Electrical Power Engineering</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-bi-1010-ue</td>
<td>Electrical Power Engineering</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Introduction to Electrodynamics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Herbert De Gersem

1 Content
Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi-conductor transmission lines (capacitance, inductance, and conductance matrix), transmission line theory, velocity definitions, basics of rectangular waveguides.

2 Learning objectives / Learning Outcomes
Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space and on transmission lines. They are able to recognize and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools.

3 Recommended prerequisite for participation
Lecture notes. Further literature recommendations are given in the course.

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 180 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT

7 References
Lecture notes. Further literature recommendations are given in the course.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1010-vl</td>
<td>Introduction to Electrodynamics</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1010-ue</td>
<td>Introduction to Electrodynamics</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Module name
Fundamentals of Signal Processing

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1030</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
</tr>
</tbody>
</table>

## 1 Content
The course covers the following topics:
- The basic concepts of stochastic
- The sampling theorem
- Discrete-time noise processes and their properties
- Description of noise processes in the frequency domain
- Linear time-invariant systems: FIR and IIR filters
- Filtering of noise processes: AR, MA, and ARMA models
- The Matched filter
- The Wiener filter
- Properties of estimators
- The method of least squares

## 2 Learning objectives / Learning Outcomes
The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.

## 3 Recommended prerequisite for participation

## 4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

## 5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)  

## 6 Usability of this module
BSc ETiT, BSc MEC

## 7 References
Lecture notes and slides can be downloaded here:
- [http://www.spg.tu-darmstadt.de](http://www.spg.tu-darmstadt.de)
- Moodle platform

Further reading:

## Courses
1.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1030-vl</td>
<td>Fundamentals of Signal Processing</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-zo-1030-ue</td>
<td>Fundamentals of Signal Processing</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Microelectronic Devices

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-1010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. rer. nat. Udo Eugen Schwalke

1 Content
- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

2 Learning objectives / Learning Outcomes
- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

3 Recommended prerequisite for participation
Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT

7 References
Skript: Microelectronic devices - the Basics
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229

Courses

1.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-1010-vl</td>
<td>Microelectronic Devices</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-sw-1010-ue</td>
<td>Microelectronic Devices</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.1 Lecture
<table>
<thead>
<tr>
<th>Module name</th>
<th>Microwave Engineering I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-jk-1020</td>
</tr>
<tr>
<td>Credit Points</td>
<td>6 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Self study</td>
<td>120 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
</tr>
</tbody>
</table>

## 1 Content
Electromagnetic spectrum, kinds of transmission media, frequency ranges, bit rates, applications; Radio-Frequency (RF) and Microwave Circuits, Components and Modules, Passive RF Circuits with R-, L- and C-Lumped Elements: Resonant and Equivalent RLC Circuits, Graphical Representation of RF Circuits with the Smith Chart, Lumped-Element Impedance Matching; Theory and Applications of Transmission Lines: General Transmission-Line Equations, Lossless Transmission Lines as Circuit Elements, Line Terminations, Transmission-Line devices; Scattering-Matrix Formulation of N-Port RF Devices: Characterization of Microwave Networks, Concatenation of Two S-Matrixes, Applications of S-Parameters; Passive microwave components: waveguide splitter, circulator, directional coupler, filter, attenuator, matching network; Antennas: Antenna performance parameter, Ideal dipole with uniform current distribution, Antenna arrays of ideal dipoles, Image theory, Antenna modelling, Transmission Factor and Power Budget of Radio Links: Friis transmission equation, Gain and effective aperture of antennas, Radar equation, System noise temperature, Antenna noise temperature, Power budget of radio links, Basic propagation effects: reflection, transmission, scattering, diffraction; The radio channel: The two-ray propagation model, Doppler shift Multipath propagation, Stochastic behaviour of the mobile radio channel

## 2 Learning objectives / Learning Outcomes

## 3 Recommended prerequisite for participation
Nachrichtentechnik, Grundlagen der Technischen Elektrodynamik

## 4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

## 5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

## 6 Usability of this module
BSc ETiT, Wi-ETiT

## 7 References
Script will be hand out; Literature will be recommended in first lecture

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1020-vl</td>
<td>Microwave Engineering I</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1020-ue</td>
<td>Microwave Engineering I</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
High Voltage Technology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-1020</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1. **Content**

   Choice of Voltage Level, Generation of High AC Voltage, Generation of High DC Voltage, Generation of Impulse Voltages, Measurement of High AC/DC/Impulse Voltages, Electrical Fields, Two excursions to manufacturers of high voltage products

2. **Learning objectives / Learning Outcomes**

   The students know why electrical energy is transported and distributed at high voltages and what is the optimal voltage level for different purposes; they are able to identify different basic kinds of electrical stress in the system; they know how to generate and to measure high test voltages in the laboratory; they have understood the requirements in the test standards and why standards are so important at all; they are able to interpret and correctly apply the standards; they know the basic test circuits for generating alternating, direct and impulse voltages, and they can extend and adopt them for special purposes; they are aware of the particular problems of high-voltage measuring techniques and are able to apply high-voltage measuring systems and optimize them for particular tasks; thus, in sum they are basically prepared to plan, erect and operate a high-voltage test laboratory; they can analytically solve the electrical field equations for basic electrode configurations and make use of them for optimizing configurations with regard to dielectric strength; they know about surge propagation on lines and are aware that this is also relevant for impulse measuring techniques and how to handle related problems.

3. **Recommended prerequisite for participation**

4. **Form of examination**

   Module final exam:
   - Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5. **Grading**

   Module final exam:
   - Module exam (Technical examination, Written Examination, weighting: 100%)

6. **Usability of this module**

   BSc ETiT

7. **References**

   - All lecture slides (ca. 600 pcs.) available for download
   - Kind, Feser: High-voltage test techniques, SBA publications
   - Kind, Kärner: High-voltage insulation technology, Vieweg

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-1020-vl</td>
<td>High Voltage Technology I</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-1020-ue</td>
<td>High Voltage Technology I</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name

**Information Theory I**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**

English

**Module owner**

Prof. Dr. techn. Heinz Köppl

---

1. **Content**

   This lecture course introduces the fundamentals of information and network information theory.

   **Outline:**
   - information, uncertainty, entropy, mutual information, capacity, differential entropy, typical sequences,
   - Gaussian channels, basics of source and channel coding, linear block codes, Shannon's source coding theorem,
   - Shannon's channel coding theorem, capacity of Gaussian channels, capacity of bandlimited channels,
   - Shannon's bound, bandwidth efficiency, capacity of multiple parallel channels and waterfilling, Gaussian vector channel, Multiple Access Channel, Broadcast Channel, rate region...

2. **Learning objectives / Learning Outcomes**

   Students will understand the fundamentals of classic information theory.

3. **Recommended prerequisite for participation**

   Knowledge of basic communication theory and probability theory.

4. **Form of examination**

   Module final exam:
   - Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5. **Grading**

   Module final exam:
   - Module exam (Technical examination, Written Examination, weighting: 100%)

6. **Usability of this module**

   BSc ETiT, BSc iST, MSc iCE, BSc Wi-ETiT, BSc/MSc CE

7. **References**


---

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-1010-vl</td>
<td>Information Theory I</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>18-kp-1010-ue</td>
<td>Information Theory I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Communication Networks I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
</tbody>
</table>

1 Content
In this class the technologies that make today’s communication networks work are introduced and discussed.
This lecture covers basic knowledge about communication networks and discusses in detail the physical layer, the data link layer, the network layer and parts of the transport layer.
The physical layer, which is responsible for an adequate transmission across a channel, is discussed briefly.
Next, error control, flow control and medium access mechanisms of the data link layer are presented. Then
the network layer is discussed. It comprises mainly routing and congestion control algorithms. After that
basic functionalities of the transport layer are discussed. This includes UDP and TCP. The Internet is thor-
oughly studied throughout the class.
Detailed Topics are:
- ISO-OSI and TCP/IP layer models
- Tasks and properties of the physical layer
- Physical layer coding techniques
- Services and protocols of the data link layer
- Flow control (sliding window)
- Applications: LAN, MAN, High-Speed LAN, WAN
- Services of the network layer
- Routing algorithms
- Broadcast and Multicast routing
- Congestion Control
- Addressing
- Internet protocol (IP)
- Internetworking
- Mobile networking
- Services and protocols of the transport layer
- TCP, UDP

2 Learning objectives / Learning Outcomes
This lecture teaches about basic functionalities, services, protocols, algorithms and standards of network
communication systems. Competencies acquired are basic knowledge about the lower four ISO-OSI lay-
ers: physical layer, datalink layer, network layer and transport layer; Furthermore, basic knowledge about
communication networks is taught. Attendants will learn about the functionality of today’s network tech-
nologies and the Internet.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 Usability of this module
Wi-CS, Wi-ETiT, BSc CS, BSc ETiT, BSc iST

7 References
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1010-vl</td>
<td>Communication Networks I</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-sm-1010-ue</td>
<td>Communication Networks I</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

1.1 Lecture

References:
- Larry L. Peterson, Bruce S. Davie: Computernetze, Ein modernes Lehrbuch, 2. Auflage, Dpunkt Verlag, 2000
Module name
Communication Technology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1020</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Anja Klein

Content

Learning objectives / Learning Outcomes
After completion of the lecture, students possess the ability to:

- classify signals and communication systems,
- understand, model and analyse basic components of communication systems,
- understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,
- model and analyse base-band communication systems,
- describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,
- understand, model, evaluate, compare and apply linear modulation schemes,
- design receiver structures for different modulation schemes,
- detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,
- understand and model OFDM,
- understand and model CDMA,
- understand and compare the basic properties of multiple access schemes.

Recommended prerequisite for participation
Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV

Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC

References
Will be announced in the lecture

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1020-vl</td>
<td>Communication Technology I</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-kl-1020-ue</td>
<td>Communication Technology I</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name
Power Electronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language
German

### Module owner
Prof. Dr.-Ing. Gerd Griepentrog

### Content
Power electronic devices convert the energy from the distribution network to the form required by the load. This conversion does not wear out, can be controlled very fast and has a high efficiency. In lecture “Power Electronics“ the most important circuits required for the energy conversion are treated, using ideal switches.

The main chapters are

1.) Line commutated converters in order to understand the basic concepts of power electronic systems.
2.) Self-commutated converters (one, two and four quadrant converters, 3-phase- VSI)

### Learning objectives / Learning Outcomes
After an active participation in the lecture, as well as by solving all exercises prior to the respective tutorial students should be able to:

- Understand the ideal concept of power semiconductors
- Calculate and sketch the time-characteristics of all currents and voltages in a line-commutated converter using defined simplifications as well as represent the behavior of currents and voltages during commutation in line-commutated converters for center -tapped as well as for bridge circuits.
- Specify the basic circuit diagrams for one, two and four quadrant DC/DC converters and calculate the characteristics of voltages and currents in these circuits.
- Explain the function of single-phase and three-phase voltage source inverters and calculate the currents and voltages in these circuits using defined simplifications.
- Understand the concept and operation of HVDC transmission

### Recommended prerequisite for participation
Mathe I und II, ETIT I und II, Energietechnik

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

### Usability of this module
MSc ETIT, MSc MEC, Wi-ETIT

### References
Lecture notes, instructions for exercises are available for download in Moodle.

Literature:
Heumann, K.: „Grundlagen der Leistungselektronik“; Teubner; Stuttgart; 1985
Lappe, R.: „Leistungselektronik“; Springer-Verlag; 1988
Mohan, Undeland, Robbins: Power Electronics: Converters, Applications and Design; John Wiley Verlag; New York; 2003
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1010-vl</td>
<td>Power Electronics</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-gt-1010-ue</td>
<td>Power Electronics</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
## Module name

**Logic Design**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language

**German**

#### Module owner

Prof. Dr.-Ing. Christian Hochberger

### Content

Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits

### Learning objectives / Learning Outcomes

By this module, Students will be enabled to

- rewrite boolean expressions and transform them into circuits of logic gates
- analyze and synthesize digital circuits
- describe digital circuits in a hardware description language
- extract finite state machines from informal descriptions and implement them with synchronous circuits

### Recommended prerequisite for participation

### Form of examination

Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

### Grading

Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

### Usability of this module

BSc ETiT, BSc MEC, BSc Wi-ETiT

### References

R.H. Katz: Contemporary Logic Design

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1010-vl</td>
<td>Logic Design</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-hb-1010-ue</td>
<td>Logic Design</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
## Content

The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force and acceleration).

In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).

The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.

The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- Computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

## Learning objectives / Learning Outcomes

The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.

In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

## Recommended prerequisite for participation

Basics of ETiT I-III, Math I-III, Electronic

## Form of examination

Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)
- Module accompanying exam:

  - [18-kn-1011-pr] (Study achievements, Optional, Standard BWS)

## Grading

Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 4)
- Module accompanying exam:

  - [18-kn-1011-pr] (Study achievements, Optional, weighting: 2)

## Usability of this module

BSc ETiT, BSc Wi-ETiT, BSc MEC

## References

1.1 Lecture
- Slide set of lecture
- Exercise documents
- Practical experiment manuals

| Courses |
|------------------|------------------|------------------|
| **Course Nr.** 18-kn-1011-vl | **Course name** Measuring Technique | **Type** Lecture | **SWS** 2 |
| **Instructor** Prof. Dr. Mario Kupnik | | |

| Courses |
|------------------|------------------|------------------|
| **Course Nr.** 18-kn-1011-pr | **Course name** Measuring Technique Lab | **Type** Internship | **SWS** 2 |
| **Instructor** Prof. Dr. Mario Kupnik | | |

| Courses |
|------------------|------------------|------------------|
| **Course Nr.** 18-kn-1011-ue | **Course name** Measuring Technique | **Type** Practice | **SWS** 1 |
| **Instructor** Prof. Dr. Mario Kupnik | | |
Module name
Fundamentals of Communication

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

<table>
<thead>
<tr>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
</tr>
</tbody>
</table>

1 Content
Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.

Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.

Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude-, pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.

Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.

2 Learning objectives / Learning Outcomes
Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.

The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.

3 Recommended prerequisite for participation
Deterministic Signals and Systems

4 Form of examination
Module final exam:
  - Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
  - Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, Wi-ETiT

7 References

1.1 Lecture

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td>18-jk-1010-vl</td>
</tr>
<tr>
<td>18-jk-1010-ue</td>
</tr>
</tbody>
</table>

1.1 Lecture
Module name
Optical Communications 1 – Components

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1060</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Franko Küppers

1 Content
Optical telecommunication and data networks
Optical transmission systems
The nature of light / wave-particle dualism
Wave equation / planar wave
Polarization
Absorption, transmission, reflection, refraction
Connectors and splices
Mirrors, HR-/AR coatings
Film waveguides
Fiber-optic waveguides
Attenuation, modes, dispersion
Fiber types
Dispersion and dispersion compensation
Kerr nonlinearity and self-phase modulation
Optical filters
Wavelength division multiplexers
Magneto-optical effect / optical isolator / circulator
Lasers / basics, concepts, types
Erbium-doped fiber lasers / amplifiers (EDFL / EDFA)
Optical semiconductor laser / amplifier (laser diode)
Electro-optic modulator
Other selected components and devices

2 Learning objectives / Learning Outcomes
Students understand concepts, basics of physics, design criteria and system requirements (component specifications) of the most important passive and active components of optical communications.

3 Recommended prerequisite for participation
ET 1-4, Physics

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100%)

6 Usability of this module
BSc ETiT, MSc ETiT, MSc iCE

7 References
Lecture slides
Textbook (M. Cvijetic, I. B. Djordjevic: „Advanced Optical Communication Systems and Networks“)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1060-vl</td>
<td>Optical Communications 1 – Components</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-ku-1060-ue</td>
<td>Optical Communications 1 – Components</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
## Module name
Photonic I - Basics and Applications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1020</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

### Content
- The nature of light / wave-particle dualism
- Emission, absorption, transmission, reflection
- Lasers: Basics, concepts, types
- Applications of principles of photonics and of lasers

### Learning objectives / Learning Outcomes
Students understand selected, fundamental concepts of photonics and their respective basics of physics, and can apply them to various, selected fields of natural and engineering sciences.

### Recommended prerequisite for participation
ET1

### Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

### Usability of this module
BSc ETiT, BSc MEC, BSc iST

### References
Lecture slides, selected literature, textbook (will be announced at the start of every course semester)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1020-se</td>
<td>Photonic I - Basics and Applications</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

1.1 Lecture
Module name
Programming in Automatic Control (C/C++)

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1020</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jürgen Adamy

1. **Content**
   - Programming in LINUX, Makefiles, C - Programming (Program structures in C, pointer, developer environment and debugger), C++ (object oriented programming)

2. **Learning objectives / Learning Outcomes**
   - After attending the lecture, a student is capable of:
     1. operating LINUX computers,
     2. assembling and using makefiles,
     3. recalling and applying the syntax for standard C-blocks,
     4. explaining and applying the use of pointers,
     5. explaining the concept of object oriented programming in C++

3. **Recommended prerequisite for participation**

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Written Examination, weighting: 100%)

6. **Usability of this module**
   - BSc ETiT, BSc iST, MSc MEC, MSc Wi-ETiT

7. **References**
   - Adamy: Lecture notes

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1020-vl</td>
<td>Programming in Automatic Control (C/C++)</td>
<td>Dr.-Ing. Volker Willert</td>
<td>Lecture</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1020-ue</td>
<td>Programming in Automatic Control (C/C++)</td>
<td>Dr.-Ing. Volker Willert</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
## Module name
Computer Systems I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1020</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
</tr>
</tbody>
</table>

1 **Content**
Types of instruction sets, memory organization and its impact on the runtime, pipelining, instruction level parallelism, superscalar processors, VLIW processors, floating point numbers and operations, memory subsystem, cache types, virtual address spaces, benchmarking and performance prediction, system architecture and bus systems, peripheral devices

2 **Learning objectives / Learning Outcomes**
Successful students can analyze and evaluate processors, memory systems and bus systems. They can transform structures of high-level programming languages like subroutine calls into sequences of machine instructions. They are able to measure the performance of computers. They know how instructions are executed in modern processors and thus, they can predict the influence of a specific memory hierarchy onto the execution time of a given program. They know how internal and external bus systems work and can define the essential parameters for their dimension and operation.

3 **Recommended prerequisite for participation**
Basic knowledge of digital design as it can be obtained by the lecture “Logic Design”.

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, BSc Wi-ETiT

7 **References**
Hennessy/Patterson: Computer architecture - a quantitative approach

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1020-vl</td>
<td>Computer Systems I</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1020-ue</td>
<td>Computer Systems I</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module name</td>
<td>Software Engineering - Introduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-su-1010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>6 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>120 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 **Content**

The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's “Guide to the Software Engineering Body of Knowledge” - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of software architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).

During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.

2 **Learning objectives / Learning Outcomes**

This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.

After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.

3 **Recommended prerequisite for participation**

sound knowledge of an object-oriented programming language (preferably Java)

4 **Form of examination**

Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 **Grading**

Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 **Usability of this module**

BSc ETiT, BSc iST, BSc Wi-ETiT

7 **References**

www.es.tu-darmstadt.de/lehre/se-i-v/

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1010-vl</td>
<td>Software Engineering - Introduction</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1010-ue</td>
<td>Software Engineering - Introduction</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name
**System Dynamics and Control Systems I**

<table>
<thead>
<tr>
<th><strong>Module Nr.</strong></th>
<th><strong>Credit Points</strong></th>
<th><strong>Workload</strong></th>
<th><strong>Self study</strong></th>
<th><strong>Duration</strong></th>
<th><strong>Cycle offered</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1010</td>
<td>6 CP</td>
<td>180 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Language</strong></th>
<th><strong>Module owner</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

### Content
- Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization.

### Learning objectives / Learning Outcomes
Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.

### Recommended prerequisite for participation

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

### Usability of this module
BSc ETiT, BSc MEC, MSc Informatik

### References
- Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen",
- Jörgl: "Repetitorium Regelungstechnik",
- Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden",
- Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise",
- Schneider: "Regelungstechnik für Maschinenbauer",
- Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage"

### Courses

<table>
<thead>
<tr>
<th><strong>Course Nr.</strong></th>
<th><strong>Course name</strong></th>
<th><strong>Instructor</strong></th>
<th><strong>Type</strong></th>
<th><strong>SWS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1010-vl</td>
<td>System Dynamics and Control Systems I</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-ko-1010-ue</td>
<td>System Dynamics and Control Systems I</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-ko-1010-tt</td>
<td>System Dynamics and Control Systems I - Auditorium Exercise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructor</td>
<td>Type</td>
<td>SWS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Tutorial</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
System Dynamics and Automatic Control Systems II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1010</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jürgen Adamy

1 **Content**
Main topics covered are:
- Root locus method (construction and application),
- State space representation of linear systems (representation, time solution, controllability, observability, observer-based controller design)

2 **Learning objectives / Learning Outcomes**
After attending the lecture, a student is capable of: 1. constructing and evaluating the root locus of given systems, 2. describing the concept and importance of the state space for linear systems, 3. defining controllability and observability for linear systems and being able to test given systems with respect to these properties, 4. stating controller design methods using the state space, and applying them to given systems, and 5. applying the method of linearization to non-linear systems with respect to a given operating point.

3 **Recommended prerequisite for participation**
System Dynamics and Control Systems I

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 180 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

7 **References**
Adamy: Systemdynamik und Regelungstechnik II, Shaker Verlag (available for purchase at the FG office)
http://www.rtr.tu-darmstadt.de/lehre/e-learning (optionales Material)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1010</td>
<td>System Dynamics and Automatic Control Systems II</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td></td>
</tr>
<tr>
<td>18-ad-1010-ue</td>
<td>System Dynamics and Automatic Control Systems II</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td></td>
</tr>
</tbody>
</table>
## Module name
**Technical Electrodynamics**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kb-1030</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Harald Klingbeil</td>
</tr>
</tbody>
</table>

### Content
Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas.

### Learning objectives / Learning Outcomes
Starting with Maxwell’s equations the lecture’s aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks.

### Recommended prerequisite for participation
Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of “Introduction to Electrodynamics”

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 180 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

### Usability of this module
BSc ETiT, MSc Wi-ETiT

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kb-1030-vl</td>
<td>Technical Electrodynamics</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-kb-1030-ue</td>
<td>Technical Electrodynamics</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Harald Klingbeil</td>
<td></td>
</tr>
</tbody>
</table>
### Module name
**Technology of Micro- and Precision Engineering**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Helmut Schlaak

### Content
Provide insights into the various production and processing methods in micro- and precision engineering and the influence of these methods on the development of devices and components.

### Learning objectives / Learning Outcomes
To explain production processes of parts like: casting, sintering of metal and ceramic parts, injection moulding, metal injection moulding, rapid prototyping, to describe manufacturing processes of parts like: forming processes, compression moulding, shaping, deep-drawing, fine cutting machines, ultrasonic treatment, laser manufacturing, machining by etching, to classify the joining of materials by: welding, bonding, soldering, sticking, to discuss modification of material properties by: tempering, annealing, composite materials.

### Recommended prerequisite for participation

### Form of examination
**Module final exam:**
- Module exam (Technical examination, Optional, standard grading system)

### Grading
**Module final exam:**
- Module exam (Technical examination, Optional, weighting: 100%)

### Usability of this module
BSc ETiT, MSc MEC, MSc WI-ETiT

### References
Script for lecture: Technology of Micro- and Precision Engineering

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1010-vl</td>
<td>Technology of Micro- and Precision Engineering</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Helmut Schlaak

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1010-ue</td>
<td>Technology of Micro- and Precision Engineering</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Helmut Schlaak
### Module name
Computational Electromagnetics and Applications I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1030</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

1. **Content**
   - Basics FIT, electrostatics, magnetostatics, magnetoquasistatics, high frequency simulations, convergence studies, discretisation, time- and frequency domain simulations.

2. **Learning objectives / Learning Outcomes**
   - Students learn the basic concepts of the Finite Integration Technique (FIT) for the numerical solution of Maxwell's equations. Students are, furthermore, introduced to the practical application of the method for numerical field problems.

3. **Recommended prerequisite for participation**
   - Basics of Maxwell's equations, linear algebra. Recommended: Basic knowledge in knowledge in “Technical Electrodynamics”

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   - BSc ETiT

7. **References**
   - Course notes, lecture slides.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1030-vl</td>
<td>Computational Electromagnetics and Applications I</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

1.1 Lecture

43
Module name
Reliability of Electronic Devices and Materials used in Microelectronics

Module Nr. 18-sw-1020
Credit Points 3 CP
Workload 90 h
Self study 60 h
Duration 1
Cycle offered SoSe

Language German
Module owner Prof. Dr. rer. nat. Udo Eugen Schwalke

1 Content
- Introduction & motivation
- Electronic devices & materials
- Reliability: The basics & definitions
- Test procedures & data analysis
- Scaling & Reliability
- Failure mechanisms
- Lifetime predictions
- Electrostatic Discharge (ESD)
- Outlook: Future developments

2 Learning objectives / Learning Outcomes
learn about and understand various breakdown mechanisms in semiconductor devices
Understand of physical correlations of breakdown mechanisms and accelerated testing procedures for determining breakdown probability
Use statistical methods to present and extract breakdown data
learn how to increase reliability of semiconductor devices and setup of simple protective circuits
learn how to identify reliability problems in integrated circuits at an early stage, be able to apply test methods, as well as gain knowledge in methods of solving reliability issues

3 Recommended prerequisite for participation
examinations passed:
Microelectronic devices - the basics
Electrical Measuring Techniques
Laboratory Measuring Techniques
Electrical Engineering and Information Technology 1
Electrical Engineering and Information Technology 2
Laboratory ETiT 1
Laboratory ETiT 2
Mathematics 1
Mathematics 2
Introductory Physics

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, MSc MEC

7 References

1.1 Lecture
Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-1020-vl</td>
<td>Reliability of Electronic Devices and Materials used in Microelectronics</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

1.1 Lecture
Module name
C/C++ Programming Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1030</td>
<td>3 CP</td>
<td>90 h</td>
<td>45 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. rer. nat. Andreas Schürr

1 Content
The six-day programming lab is divided into two sections. In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism. The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus).

2 Learning objectives / Learning Outcomes
During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development.

3 Recommended prerequisite for participation
Java skills

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT

7 References
http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1030-pr</td>
<td>C/C++ Programming Lab</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Andreas Schürr
Module name
Electronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1011</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1 Content
18-ho-1011-vl bzw. –ue:
Semiconductor Elements: Diode, MOSFET, Bipolartransistor. Electronic Circuit Design; Basic Analog Circuits and their properties, Behavior and properties of operational amplifiers, circuit simulation with SPICE, small signal amplification, single stage amplifiers, frequency response; digital circuits: CMOS-logic

18-ho-1011-pr:
Practical experiments in the fields:
- digital circuits: FPGA-programming
- analog circuits: basic building blocks, amplifiers, operational amplifiers, filters and demodulators

2 Learning objectives / Learning Outcomes
A student is after successful attending the lecture able to
- analyse the behavior of diodes, MOS- and Bipolartransistors in simple circuits,
- assess the properties of single-transistor amplifiers (MOSFET and BJT), such as small signal behavior, input- and output-resistance;
- design inverting and non-inverting operational amplifiers with passive components and knows the ideal and non-ideal properties;
- calculate the frequency response of simple transistor circuits;
- knows the different circuit techniques (CMOS, NMOS) of logical gates and knows the basic functions (inverter, NAND, NOR).

A student is after successful attending the lab able to
- perform measurements in time and frequency domain using an oscilloscope on simple operational amplifiers;
- design and realize a traffic light controller based on a finite state machine using a FPGA as the target implementation;
- mount passive and active components on a PCB (including preparation of components, soldering) and put the system to function,
- simulate a circuit (filter) using SPICE and perform measurements on the realization.

3 Recommended prerequisite for participation
Basics of Electrical Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)
Module accompanying exam:
- [18-ho-1011-pr] (Study achievements, Optional, Standard BWS)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 4)
Module accompanying exam:
- [18-ho-1011-pr] (Study achievements, Optional, weighting: 3)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc iST, BEd

7 References
1.2 Internships
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1011-vl</td>
<td>Electronics</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-ho-1011-pr</td>
<td>Electronics Lab</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>18-ho-1011-ue</td>
<td>Electronics</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
HDL Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1090</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1. **Content**
Realisation of a VHDL- or Verilog-based VLSI System Design Project in a Team with industrial constraints

2. **Learning objectives / Learning Outcomes**
A student is, after successful completion of this module, able to 1. design, optimize and verify a complex digital system (e.g. a pipelined CPU or signal processor) using Verilog or VHDL, 2. synthesize the HDL description using commercial CAD software to a gate level description

3. **Recommended prerequisite for participation**
Mandatory Prerequisite: Lecture Computer Aided Design for System on Chips, At least one high-level Programming Language, Basic Know-How Linux/Unix, Computer Architectures

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
BSc/MSc ETiT, BSc/MSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE

7. **References**
Lecture slides „HDL: Verilog and VHDL“

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1090-pr</td>
<td>HDL Lab</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Klaus Hofmann
Module name
Mechatronics Workshop

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1050</td>
<td>2 CP</td>
<td>60 h</td>
<td>45 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

1 Content
During the mechatronic workshop students get the possibility to design and construct their own fixture, which contains a ball track and a ball elevator mechanism. Therefore dimensional plans have to be understood correctly. Afterwards all components (i.e. circuit board, rails and holders) have to be designed and manufactured within the electronic lab and the workshop, where students work independently with turning, drilling and milling machines.

The mechatronic workshop allows students to gain practical experience and knowledge in construction, assembling and PCB layout design.

2 Learning objectives / Learning Outcomes
Understanding of construction plans, circuit layout design, practical experience with turning, drilling and milling machines.

3 Recommended prerequisite for participation
You have to bring your own printed copy of the script. This is mandatory for attending the course. The script will be published on the moodle platform.

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6 Usability of this module
BSc/MSc ETiT, BSc/MSc MEC

7 References
- Lecture Notes „Mechatronics Workshop“

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1050-pr</td>
<td>Mechatronics Workshop</td>
<td>Internship</td>
<td>1</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. techn. Dr.h.c. Andreas Binder
Module name
Measuring Technique

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1011</td>
<td>6 CP</td>
<td>180 h</td>
<td>105 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. Mario Kupnik

1 Content
The module includes theoretical discussion and practical application of the measuring chain in detail on examples the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).

In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statistic safe tests).

The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.

The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- Computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

2 Learning objectives / Learning Outcomes
The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.

In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

3 Recommended prerequisite for participation
Basics of ETiT I-III, Math I-III, Electronic

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

Module accompanying exam:
- [18-kn-1011-pr] (Study achievements, Optional, Standard BWS)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 4)

Module accompanying exam:
- [18-kn-1011-pr] (Study achievements, Optional, weighting: 2)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc MEC

7 References
1.2 Internships
Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1011-vl</td>
<td>Measuring Technique</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-kn-1011-pr</td>
<td>Measuring Technique Lab</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-kn-1011-ue</td>
<td>Measuring Technique</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.2 Internships
Module name
Actuators for Mechatronic Systems Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1030</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

Content
Safety instructions; Practical experiments about electrical energy conversion and mechatronic actuators:
- Record preparation (one for each group) for every experiment.
- One exam for all practical experiments at the end of the semester.
- The mark for the students result from the practical experiments, the prepared records and the results of the 2 short exams.

Learning objectives / Learning Outcomes
The use of mechanical actors is trained and knowledge in using the actors is acquired.

Recommended prerequisite for participation
Recommended lecture "Elektrische Antriebe (MEC)" and "Maschinenelemente und Mechatronik 1"

Form of examination
Module final exam:
- Module exam (Study achievements, Written Examination, duration: 90 min, standard grading system)

Grading
Module final exam:
- Module exam (Study achievements, Written Examination, weighting: 100%)

Usability of this module
BSc MEC

References
Detailed textbook with description for the performance of the lab tests

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1030-pr</td>
<td>Actuators for Mechatronic Systems Lab</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. techn. Dr.h.c. Andreas Binder

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2090-tt</td>
<td>Laboratory Briefing</td>
<td>Tutorial</td>
<td>0</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. techn. Dr.h.c. Andreas Binder

1.2 Internships 53
1 **Content**
After a safety instruction for electrical equipment, students do lab experiments covering foundations of electrical engineering by using theoretical and experimental instructions to improve basic electrical understanding. Building up a test set autonomously and performing of measurements and evaluations in the form of logs to confirm the theoretical knowledge and lead to independent work in practice.

The following experiments are performed:
- Investigate real behavior of ohmic resistors
- Investigate real behavior of capacitors and inductors
- Calculate impedances of basic two-terminal circuits using network theory
- Measure of electrical power in AC circuits and investigate in the real behaviour of transformers
- DC technology, capacity and inductors, AC technology - Impedances and two-terminal circuits, transformer & power;

2 **Learning objectives / Learning Outcomes**
After preparing the afternoons independently and self-implementing the measurement setup and measurement tasks by active participation in the practical group and by thorough preparation of the associated measurement protocols, you should be able to:
- Perform the measurement of basic electrical parameters of DC and AC circuits, independently and in compliance with safety rules
- measuring the frequency response of passive electrical networks and resonant circuits, and electric power measurement
- the measurement of circuits for the determination of magnetic, electro-thermal and high-frequency.
- You have to be able to build and run your own measurements
- interpretations of the measurement results in terms of its technical meaning, but also their accuracy and error sources safely.

3 **Recommended prerequisite for participation**
Parallel attending the lectures and exercises, “Electrical Engineering I and II”

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
BSc ETiT

7 **References**
detailed script with instructions for the experiments; Clausert, H. / Wiesemann, G.: Grundgebiete der Elektrotechnik, Oldenbourg.1999

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1041-pr</td>
<td>Electrical Engineering and Information Technology Lab I B</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.2 Internships
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1040-pr</td>
<td>Electrical Engineering and Information Technology Lab I A</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr. Mario Kupnik

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internship</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1040-tt</td>
<td>Electrical Engineering and Information Technology I, Safety instructions and rules</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr. Mario Kupnik

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial</td>
<td>0</td>
</tr>
</tbody>
</table>
In this lab tutorial, an introduction to the software tool MatLab/Simulink will be given. The lab is split into two parts. First the fundamentals of programming in Matlab are introduced and their application to different problems is trained. In addition, an introduction to the Control System Toolbox will be given. In the second part, the knowledge gained in the first part is applied to solve a control engineering specific problem with the software tools.

Recommended prerequisite for participation
The lab should be attended in parallel or after the lecture “System Dynamics and Control Systems I”

Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

Usability of this module
BSc ETiT; BSc MEC

References
Lecture notes for the lab tutorial can be obtained at the secretariat
Lunze; Regelungstechnik I
Dorp; Bishop: Moderne Regelungssysteme
Moler: Numerical Computing with MATLAB
### Module name
Multimedia Communications Lab I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1020</td>
<td>3 CP</td>
<td>90 h</td>
<td>45 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
</tbody>
</table>

1 **Content**
The course deals with cutting edge development topics in the area of multimedia communication systems. Beside a general overview it provides a deep insight into a special development topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and basic scientific competences in one or more of the following topics:

- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia/e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Applications for distributed workflows
- Resource-based Learning

2 **Learning objectives / Learning Outcomes**
The ability to solve simple problems in the area of multimedia communication shall be acquired. Acquired competences are:

- Design of simple communication applications and protocols
- Implementing and testing of software components for distributed systems
- Application of object-oriented analysis and design techniques
- Presentation of project advances and outcomes

3 **Recommended prerequisite for participation**
Keen interest to explore basic topics of cutting edge communication and multimedia technologies. Further we expect:

- Basic experience in programming Java/C# (C/C++).
- Knowledge in computer communication networks. Lectures in Communication Networks I and/or Net Centric Systems are recommended.

4 **Form of examination**
Module final exam:

- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:

- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, BSc/MSc iST, MSc MEC, Wi-CS, Wi-ETiT, BSc/MSc CS

7 **References**
Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:


<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-sm-1020-pr</td>
</tr>
<tr>
<td>Instructor</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Internship</td>
</tr>
</tbody>
</table>
### Module name
Laboratory Course Control of Mechatronic Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1040</td>
<td>4 CP</td>
<td>120 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Ulrich Konigorski

1. **Content**
- Control of a 2-tank system.
- Control of pneumatic and hydraulic servo-drives.
- Control of a 3 mass oscillator.
- Position control of a MagLev system.
- Control of a discrete transport process with electro-pneumatic components.
- Microcontroller-based control of an electrically driven throttle valve.
- Identification of a 3 mass oscillator.
- Process control using PLC.

2. **Learning objectives / Learning Outcomes**
After this lab tutorial the students will be able to practically apply the modelling and design techniques for different dynamic systems presented in the lecture "System dynamics and control systems I" to real lab experiments and to bring them into operation at the lab setup.

3. **Recommended prerequisite for participation**
System Dynamics and Control Systems I

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Written Examination, duration: 90 min, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Written Examination, weighting: 100%)  

6. **Usability of this module**
BSc MEC

7. **References**
Lab handouts will be given to students

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1020-pr</td>
<td>Laboratory Control Engineering I</td>
<td>Internship</td>
<td>4</td>
</tr>
<tr>
<td>Module name</td>
<td>Laboratory Control Engineering I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-ko-1020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>60 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1 Content
- Control of a 2-tank system.
- Control of pneumatic and hydraulic servo-drives.
- Control of a 3 mass oscillator.
- Position control of a MagLev system.
- Control of a discrete transport process with electro-pneumatic components.
- Microcontroller-based control of an electrically driven throttle valve.
- Identification of a 3 mass oscillator.
- Process control using PLC.

### 2 Learning objectives / Learning Outcomes
After this lab tutorial the students will be able to practically apply the modelling and design techniques for different dynamic systems presented in the lecture "System dynamics and control systems I" to real lab experiments and to bring them into operation at the lab setup.

### 3 Recommended prerequisite for participation
System Dynamics and Control Systems I

### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Written Examination, duration: 90 min, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Study achievements, Written Examination, weighting: 100%)

### 6 Usability of this module
BSc ETIT

### 7 References
Lab handouts will be given to students

### Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1020-pr</td>
<td>Laboratory Control Engineering I</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Internship</td>
<td>4</td>
</tr>
</tbody>
</table>
**Module name**
Software Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1020</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr. rer. nat. Andreas Schürr

**Content**
The lab covers the following basic software development skills:
- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**Learning objectives / Learning Outcomes**
Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**Recommended prerequisite for participation**
Basics in Java (as taught in Introduction to Computer Science for Engineers). Windows-Account of the ETIT PC-Pool

**Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

**Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

**Usability of this module**
BSc ETiT, BSc Wi-ETiT

**References**
www.es.tu-darmstadt.de/lehre/sp/

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1020-pr</td>
<td>Software Lab</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr. rer. nat. Andreas Schürr

1.2 Internships
**Module name**
Software Lab Computational Electromagnetics and Applications I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>195 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

1. **Content**

2. **Learning objectives / Learning Outcomes**
   Students will understand basic concepts of numerical solution techniques to field problems related to different physical domains. They will exhibit the ability to write small simulation programs in Matlab.

3. **Recommended prerequisite for participation**
   Recommended: “Computational Electromagnetics and Applications” (also in parallel).

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   BSc ETiT, MSc ETiT, BSc CE

7. **References**
   Course notes will be provided.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1041-pr</td>
<td>Software Lab Computational Electromagnetics and Applications I</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Herbert De Gersem
### 1.3 Seminars

<table>
<thead>
<tr>
<th>Module name</th>
<th>Photonic I - Basics and Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-ku-1020</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>4 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>120 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>90 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe</td>
</tr>
</tbody>
</table>

| Language                                         | German                               |
| **Module owner**                                 | Prof. Dr.-Ing. Franko Küppers        |

1. **Content**
   - The nature of light / wave-particle dualism
   - Emission, absorption, transmission, reflection
   - Lasers: Basics, concepts, types
   - Applications of principles of photonics and of lasers

2. **Learning objectives / Learning Outcomes**
   - Students understand selected, fundamental concepts of photonics and their respective basics of physics, and can apply them to various, selected fields of natural and engineering sciences.

3. **Recommended prerequisite for participation**
   - ET1

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, weighting: 100%)

6. **Usability of this module**
   - BSc ETiT, BSc MEC, BSc iST

7. **References**
   - Lecture slides, selected literature, textbook (will be announced at the start of every course semester)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1020-se</td>
<td>Photonic I - Basics and Applications</td>
<td>Seminar</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

63
Module name
Seminar Electronic Circuits

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1070</td>
<td>4 CP</td>
<td>120 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1 Content
Analysis of state-of-the-art circuit concepts and presentation of selected examples

2 Learning objectives / Learning Outcomes
After attending the seminar, a student is capable of analysing of state-of-the-art circuit concepts and preparing didactical materials and presentations, based on the know-how gained in the lectures “Electronics” and “Analog Integrated Circuit Design”

3 Recommended prerequisite for participation
Electronics, Analog Integrated Circuit Design

4 Form of examination
Module final exam:
• Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT

7 References
Will be provided at the begin of the seminar

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1070-se</td>
<td>Seminar Electronic Circuits</td>
<td>Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Klaus Hofmann
<table>
<thead>
<tr>
<th>Module name</th>
<th>Seminar Terahertz Components &amp; Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-pr-1010</td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
</tr>
<tr>
<td>Self study</td>
<td>90 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German and English</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
</tr>
</tbody>
</table>

1 **Content**  
Investigating and solving specific problems concerning the development of Terahertz devices as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:  
- Optics on chip  
- Semiconductor devices Light-matter interaction

2 **Learning objectives / Learning Outcomes**  
After completion of the course, students possess:  
- the ability to apply theoretical models to practical problems  
- deep and special knowledge in a particular field related to THz science, optics or semiconductor physics  
- the skills to find, analyze and evaluate scientific reference papers for a particular topic  
- the capability to summarize the achieved scientific findings in the form of a concise report the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 **Recommended prerequisite for participation**  
Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology

4 **Form of examination**  
Module final exam:  
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**  
Module final exam:  
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**  
BSc ETiT, BSc Wi-ETiT, BSc/MSc iST

7 **References**  
Will be announced once the topic is defined.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1010-se</td>
<td>Seminar Terahertz Components &amp; Applications</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr. rer. nat. Sascha Preu
1.4 Introductory Seminar Courses

<table>
<thead>
<tr>
<th>Module name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td><strong>Credit Points</strong></td>
</tr>
<tr>
<td>18-ad-1000</td>
<td>2 CP</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td><strong>Module owner</strong></td>
</tr>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

1. **Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
BSc ETiT, BSc MEC, BSc IST

7. **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

1. **Content**
   Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.

2. **Learning objectives / Learning Outcomes**
   The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   BSc ETiT, BSc MEC, BSc iST

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
<table>
<thead>
<tr>
<th>Module name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-hb-1000</td>
</tr>
<tr>
<td>Credit Points</td>
<td>2 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>60 h</td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
</tr>
</tbody>
</table>

1 **Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2 **Learning objectives / Learning Outcomes**
The student will be able to understand and analyze scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6 **Usability of this module**
BSc ETiT, BSc MEC, BSc iST

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>18-hb-1000-ps</th>
<th>Course name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td>Type</td>
<td>Introductory Seminar Course</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SWS</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
</tr>
</tbody>
</table>

1 Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2 Learning objectives / Learning Outcomes
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>
## Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
</tr>
</tbody>
</table>

### Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

### Learning objectives / Learning Outcomes
The student will be able to understand and analyze scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

### Recommended prerequisite for participation

### Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### Usability of this module
BSc ETiT, BSc MEC, BSc iST

### References

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

1. **Content**
Analysis of basic electronic circuits and presentation of selected examples

2. **Learning objectives / Learning Outcomes**
After attending the seminar, a student is capable of analysing basic electronic circuits and preparing didactical materials and presentations

3. **Recommended prerequisite for participation**
Electronics

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
BSc ETiT

7. **References**
Will be provided at the begin of the seminar

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
<table>
<thead>
<tr>
<th><strong>Module name</strong></th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-jk-1000</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>2 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>60 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>30 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German</td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
</tr>
</tbody>
</table>

**Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

**Learning objectives / Learning Outcomes**
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

**Recommended prerequisite for participation**

**Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

**Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

**Usability of this module**
BSc ETiT, BSc MEC, BSc iST

**References**

**Courses**

<table>
<thead>
<tr>
<th><strong>Course Nr.</strong></th>
<th>18-jk-1000-ps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course name</strong></td>
<td>Proseminar Electrical Engineering and Information Technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Instructor</strong></th>
<th>Prof. Dr.-Ing. Rolf Jakoby</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Introductory Seminar Course</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
</tr>
</tbody>
</table>

1. **Content**
   Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**
   The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**
   Basic knowledge from the first four semesters

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
# Module Name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Ulrich Konigorski

## Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

## Learning objectives / Learning Outcomes
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

## Recommended prerequisite for participation

## Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

## Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

## Usability of this module
BSc ETiT, BSc MEC, BSc iST

## References

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Ralf Steinmetz

1 Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.

2 Learning objectives / Learning Outcomes
The students will be able to understand and analyse scientific papers, as well as to present technical facts in a proper and well structured manner. They know how to summarize and present publications from a given topic area.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
  • Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
  • Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ralf Steinmetz
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1000-ps</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. rer. nat. Andreas Schürr

1. Content
In this course, the students produce scientific reports from changing subject areas. Each student has to explore a subject related to IT system development and produce a written report as well as a final talk with a presentation. A list of the subjects of the current semester is available at www.es.tu-darmstadt.de/lehre/sst.

2. Learning objectives / Learning Outcomes
After a successful participation, the students will be able to explore an unknown topic under scientific aspects. The students learn to support the exploration by a literature research and to analyze the subject critically. They achieve the skills to present a definite subject in a written report as well as in an oral presentation.

3. Recommended prerequisite for participation
Introduction to Computer Science for Engineers, Software Lab; Software Engineering I or comparable skills

4. Form of examination
Module final exam:
• Module exam (Study achievements, Optional, standard grading system)

5. Grading
Module final exam:
• Module exam (Study achievements, Optional, weighting: 100 %)

6. Usability of this module
BSc ETiT, Informatik, IST, Wi-ETiT

7. References
http://www.es.tu-darmstadt.de/lehre/proseminar-etit/

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Andreas Schürr

1.4 Introductory Seminar Courses
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
</tr>
</tbody>
</table>

1 Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2 Learning objectives / Learning Outcomes
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc MEC, BSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Udo Eugen Schwalke

1.4 Introductory Seminar Courses
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

1 **Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.

2 **Learning objectives / Learning Outcomes**
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, BSc MEC, BSc iST

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Abdelhak Zoubir

1 Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2 Learning objectives / Learning Outcomes
The student will be able to understand and analyze scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
• Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Optional, weighting: 100%)

6 Usability of this module
BSc ETiT, BSc MEC, BSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Abdelhak Zoubir

1.4 Introductory Seminar Courses
<table>
<thead>
<tr>
<th>Module name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-hs-1000</td>
</tr>
<tr>
<td>Credit Points</td>
<td>2 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>60 h</td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
</tr>
</tbody>
</table>

1 **Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2 **Learning objectives / Learning Outcomes**
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, BSc MEC, BSc iST

7 **References**

---

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

---

1.4 Introductory Seminar Courses
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr.-Ing. Gerd Griepentrog

---

#### 1 Content
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

#### 2 Learning objectives / Learning Outcomes
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

#### 3 Recommended prerequisite for participation

#### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

#### 5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

#### 6 Usability of this module
BSc ETiT, BSc MEC, BSc iST

#### 7 References

---

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
<table>
<thead>
<tr>
<th>Module name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-ku-1000</td>
</tr>
<tr>
<td>Credit Points</td>
<td>2 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>60 h</td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

1. **Content**
   Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**
   The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**
   Course “Wissenschaftliche Arbeiten schreiben und präsentieren”

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   BSc ETiT, BSc MEC, BSc iST

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
<table>
<thead>
<tr>
<th>Module name</th>
<th>Proseminar Electrical Engineering and Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-sc-1000</td>
</tr>
<tr>
<td>Credit Points</td>
<td>2 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>60 h</td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr. rer. nat. Sebastian Schöps</td>
</tr>
</tbody>
</table>

1. **Content**

   Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**

   The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**

4. **Form of examination**

   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**

   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100%)

6. **Usability of this module**

   BSc ETiT, BSc MEC, BSc IST

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sc-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Prof. Dr. rer. nat. Sebastian Schöps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Introductory Seminar Course</td>
</tr>
<tr>
<td>SWS</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
</tr>
</tbody>
</table>

1. **Content**
   Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**
The student will be able to understand and analyze scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100%)

6. **Usability of this module**
   BSc ETiT, BSc MEC, BSc iST

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
Module name
Proseminar ETiT Option MPE

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Helmut Schlaak

1 Content
Intense theoretical engagement with development methodology as an individual, but also within a project group at a specific didactic meaningful example. Self-developed presentations for each phase of development and a technical final report drawn up with the project team are evaluated and used as test performance.

2 Learning objectives / Learning Outcomes
Students learn the five major stages of development methodology: 1) Clarification of the task with requirements analysis and state of the art research; 2) Conceptional design with abstracting the problem, working out the sub-problems, development of partial solutions, performing objective evaluations and selection of the overall concept; 3) Creating and designing with determining the necessary parameters, setting up models, running simulations and converting the results into a final form; 4) Elaborating with creating the complete set of production documents such as bills of materials, engineering drawings, assembly instructions, circuit layouts, and test criteria; 5) Putting into operation with gaining experience in the comparison of theoretical knowledge and practical implementation.

In addition, tools for project planning and resource allocation, issues and assistance for productive team work and knowledge to successfully create technical reports and presentations are learned.

3 Recommended prerequisite for participation
Parallel attendance of Product Development Methodology I

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc WI-ETiT

7 References
Script: Development Methodology (PEM)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1000-ps</td>
<td>Proseminar ETiT Option MPE</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Helmut Schlaak
### Module name
Proseminar Electrical Engineering and Information Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-st-1000</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr. rer. nat. Florian Steinke

1. **Content**
Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multimedia technology.

2. **Learning objectives / Learning Outcomes**
The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.

3. **Recommended prerequisite for participation**

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6. **Usability of this module**
BSc ETiT, BSc MEC, BSc iST

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-st-1000-ps</td>
<td>Proseminar Electrical Engineering and Information Technology</td>
<td>Prof. Dr. rer. nat. Florian Steinke</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
</tbody>
</table>

1.4 Introductory Seminar Courses
1.5 Project Seminars

**Module name**
Product Development Methodology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1021</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Helmut Schlaak

1. **Content**
Practical experience in the methods used for the development of technical products. Work in a project team.

2. **Learning objectives / Learning Outcomes**
Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as part lists, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect.

3. **Recommended prerequisite for participation**
Parallel attendance of Proseminar ETiT Option MPE

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6. **Usability of this module**
BSc ETiT, BSc WI-ETiT

7. **References**
Script: Development Methodology (PEM)

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1021-pj</td>
<td>Product Development Methodology I</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Helmut Schlaak
Module name
Project Seminar Particle Accelerator Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kb-1020</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Harald Klingbeil

1 **Content**
Work on a more complex project in the field of particle accelerator technology. Depending on the specific problem, measurement aspects, analytical aspects, and simulation aspects will be included.

2 **Learning objectives / Learning Outcomes**
Students will be able to solve complex engineering problems with different measurement techniques, analytical approaches or simulation methods. They are able to estimate measurement errors and modeling and simulation errors. They know how to present the results on a scientific level in talks and a paper. Students are able to organize teamwork.

3 **Recommended prerequisite for participation**
Good understanding of electromagnetic fields, broad knowledge of different electrical engineering disciplines.

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 **Usability of this module**
BSc ETIT

7 **References**
Suitable material is provided based on specific problem.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kb-1020-pj</td>
<td>Project Seminar Particle Accelerator Technology</td>
<td>Prof. Dr.-Ing. Harald Klingbeil</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
<tr>
<td><strong>Module name</strong></td>
<td>Project Seminar Electromagnetic CAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-dg-1060</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>8 CP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>240 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>180 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe/SoSe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German and English</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**
   Work on a more complex project in numerical field calculation using commercial tools or own software.

2. **Learning objectives / Learning Outcomes**
   Students will be able to simulate complex engineering problems with numerical field simulation software. They are able to estimate modelling and numerical errors. They know how to present the results on a scientific level in talks and a paper. Students are able to organize teamwork.

3. **Recommended prerequisite for participation**
   Good understanding of electromagnetic fields, knowledge about numerical simulation methods.

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   MSc ETiT

7. **References**
   Course notes “Computational Electromagnetics and Applications I-III”, further material is provided.

<table>
<thead>
<tr>
<th><strong>Courses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td><strong>Course name</strong></td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td><strong>SWS</strong></td>
</tr>
</tbody>
</table>
### Module name
Project Seminar Integrated Electronic Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1060</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

1. **Content**
   - Research-oriented project in the domain of Integrated Electronic Systems or Microelectronic System Design, Final Report and Presentation of Results in a Team

2. **Learning objectives / Learning Outcomes**
   - After attending this project seminar, a student is able to fulfill/implement a given task or project in the domain of Integrated Electronic System design (optionally in a group of students), write a final report and present the results to an audience.

3. **Recommended prerequisite for participation**
   - Lecture Analog Integrated Circuit Design

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, weighting: 100%)

6. **Usability of this module**
   - BSc ETiT, Wi ETiT

7. **References**
   - Material on the subject will be handed out

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-1060-pj</td>
<td>Project Seminar Integrated Electronic Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.

2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of communication and sensor systems to practical problems
- deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Rolf Jakoby

1.5 Project Seminars
Module name
Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Anja Klein

1 Content
Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one’s own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.

2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of communication and sensor systems to practical problems
- deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Anja Klein

1.5 Project Seminars
Module name
Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Franko Küppers

1 Content
Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a a given task by one’s own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.

2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of communication and sensor systems to practical problems
- deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
# Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

## Language
German and English

## Module owner
Prof. Dr.-Ing. Marius Pesavento

## 1 Content
Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.

## 2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of communication and sensor systems to practical problems
- deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

## 3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks

## 4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

## 5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

## 6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

## 7 References
Will be announced in the lecture

## Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

## Instructor
Prof. Dr.-Ing. Marius Pesavento

---

1.5 Project Seminars
### Module name
Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1041-pj</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr.-Ing. Abdelhak Zoubir

### Content
Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.

### Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of communication and sensor systems to practical problems
- deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

### Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks

### Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

### References
Will be announced in the lecture

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Abdelhak Zoubir
Module name
Project Seminar Communication and Sensor Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1041</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr. rer. nat. Sascha Preu

1 Content
Investigating and solving specific problems concerning the development of Terahertz sensors and systems as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:
- Optics on chip
- Semiconductor devices
- Light-matter interaction

2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply theoretical models to practical problems
- deep and special knowledge in a particular field related to THz science, optics or semiconductor physics
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 Recommended prerequisite for participation
Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced once the topic is defined.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1041-pj</td>
<td>Project Seminar Communication and Sensor Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Sascha Preu

1.5 Project Seminars
**Module name**
Multimedia Communications Project I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1030</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr.-Ing. Ralf Steinmetz

---

### 1 Content

The course deals with cutting edge scientific and development topics in the area of multimedia communication systems. Besides a general overview, it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics:

- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia/e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Applications for distributed workflows
- Resource-based Learning

---

### 2 Learning objectives / Learning Outcomes

The ability to solve and evaluate technical problems in the area of design and development of future multimedia communication networks and applications using state of the art scientific methods. Acquired competences are among the following:

- Searching and reading of project relevant literature
- Design of communication applications and protocols
- Implementing and testing of software components
- Application of object-orient analysis and design techniques
- Acquisition of project management techniques for small development teams
- Evaluation and analyzing of technical scientific experiments
- Writing of software documentation and project reports
- Presentation of project advances and outcomes

---

### 3 Recommended prerequisite for participation

Keen interest to develop and explore challenging solutions and applications in cutting edge multimedia communication systems. Further we expect:

- Basic experience in programming Java/C# (C/C++).
- Basic knowledge in Object oriented analysis and design.
- Knowledge in computer communication networks. Lectures in Communication Networks I and/or Net Centric Systems are recommended.

---

### 4 Form of examination

Module final exam:

- Module exam (Study achievements, Optional, standard grading system)

---

### 5 Grading

Module final exam:

- Module exam (Study achievements, Optional, weighting: 100 %)

---

### 6 Usability of this module

1.5 Project Seminars
Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Erich Gamma, Richard Helm, Ralph E. Johnson: “Design Patterns: Objects of Reusable Object Oriented Software” (ISBN 0-201-63361-2)

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-1030-pj</td>
<td>Multimedia Communications Project I</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr.-Ing. Ralf Steinmetz
Module name
Project Seminar Telecommunications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1040</td>
<td>10 CP</td>
<td>300 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Anja Klein

1 Content
Investigating and solving specific problems concerning mobile communications (Problems concerning communications technology, microwave technology, signal processing etc. are possible, topics will be depicted out of the recent research topics of the involved labs), working on a given task by one’s own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusion by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience

2 Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply methods of telecommunication to practical problems
- deep and special knowledge in a particular field of telecommunication (communications engineering, RF technology, signal processing)
- the skills to find, analyse and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report
- the ability to present and discuss achieved results in the form of a presentation in front of an audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology

4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-1040-pj</td>
<td>Project Seminar Telecommunications</td>
<td>Project Seminar</td>
<td>6</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Project Seminar Telecommunications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1040</td>
<td>10 CP</td>
<td>300 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Marius Pesavento

1 Content
Investigating and solving specific problems concerning mobile communications (Problems concerning microwave technology, communications technology, signal processing etc. are possible, topics will be depicted out of the recent research topics of the involved labs)
working on a a given task by one's own hand organizing and structuring of a seminar task searching and analyzing of scientific reference publications for a given task summarizing achieved results and conclusion by means of a written report
presenting achieved results and conclusions and defending them in an oral discussion including audience

2 Learning objectives / Learning Outcomes
After completion of the course, students possess
• the knowledge to apply methods of mobile communication to practical problems
• a deep knowledge in a specific area of mobile communication (communication technology, microwave technology, signal processing etc.)
• the ability to search, analyze and evaluate scientific reference literature for a given task
• skills to summarize in a short report achieved results from an investigation
• the capability to present achieved results from an investigation in an oral presentation and defend them in an oral discussion including audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology

4 Form of examination
Module final exam:
• Module exam (Study achievement, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievement, Optional, weighting: 100%)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-1040-pj</td>
<td>Project Seminar Telecommunications</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td>Project Seminar</td>
<td>6</td>
</tr>
</tbody>
</table>
Module name
Project Seminar Telecommunications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1040</td>
<td>10 CP</td>
<td>300 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Investigating and solving specific problems concerning mobile communications (Problems concerning microwave technology, communications technology, signal processing etc. are possible, topics will be depicted out of the recent research topics of the involved labs)
working on a given task by one's own hand organizing and structuring of a seminar task
searching and analyzing of scientific reference publications for a given task
summarizing achieved results and conclusion by means of a written report
presenting achieved results and conclusions and defending them in an oral discussion including audience

2 Learning objectives / Learning Outcomes
After completion of the course, students possess
- the knowledge to apply methods of mobile communication to practical problems
- a deep knowledge in a specific area of mobile communication (communication technology, microwave technology, signal processing etc.)
- the ability to search, analyze and evaluate scientific reference literature for a given task
- skills to summarize in a short report achieved results from an investigation
- the capability to present achieved results from an investigation in an oral presentation and defend them in an oral discussion including audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-1040-pj</td>
<td>Project Seminar Telecommunications</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Rolf Jakoby

Type
Project Seminar

SWS
6
Module name: Project Seminar Telecommunications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1040</td>
<td>10 CP</td>
<td>300 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language: German and English

Module owner: Prof. Dr.-Ing. Franko Küppers

1. **Content**
   - Investigating and solving specific problems concerning mobile communications (Problems concerning microwave technology, communications technology, signal processing etc. are possible, topics will be depicted out of the recent research topics of the involved labs)
   - Working on a given task by one's own hand organizing and structuring of a seminar task
   - Searching and analyzing of scientific reference publications for a given task
   - Summarizing achieved results and conclusion by means of a written report
   - Presenting achieved results and conclusions and defending them in an oral discussion including audience

2. **Learning objectives / Learning Outcomes**
   - After completion of the course, students possess
     - The knowledge to apply methods of mobile communication to practical problems
     - A deep knowledge in a specific area of mobile communication (communication technology, microwave technology, signal processing etc.)
     - The ability to search, analyze and evaluate scientific reference literature for a given task
     - Skills to summarize in a short report achieved results from an investigation
     - The capability to present achieved results from an investigation in an oral presentation and defend them in an oral discussion including audience

3. **Recommended prerequisite for participation**
   - Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   - BSc ETIT, BSc Wi-ETIT, BSc CE, BSc iST, BSc MEC

7. **References**
   - Will be announced in the lecture

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-1040-pj</td>
<td>Project Seminar Telecommunications</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td>Project Seminar</td>
<td>6</td>
</tr>
</tbody>
</table>

1.5 Project Seminars
Module name
Project Seminar Telecommunications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1040</td>
<td>10 CP</td>
<td>300 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Abdelhak Zoubir

1 Content
Investigating and solving specific problems concerning mobile communications (Problems concerning microwave technology, communications technology, signal processing etc. are possible, topics will be depicted out of the recent research topics of the involved labs)
working on a a given task by one's own hand organizing and structuring of a seminar task
searching and analyzing of scientific reference publications for a given task summarizing achieved results and conclusion by means of a written report
presenting achieved results and conclusions and defending them in an oral discussion including audience

2 Learning objectives / Learning Outcomes
After completion of the course, students possess
• the knowledge to apply methods of mobile communication to practical problems
• a deep knowledge in a specific area of mobile communication (communication technology, microwave technology, signal processing etc.)
• the ability to search, analyze and evaluate scientific reference literature for a given task
• skills to summarize in a short report achieved results from an investigation
• the capability to present achieved results from an investigation in an oral presentation and defend them in an oral discussion including audience

3 Recommended prerequisite for participation
Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology

4 Form of examination
Module final exam:
• Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Optional, weighting: 100%)

6 Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC

7 References
Will be announced in the lecture

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-1040-pj</td>
<td>Project Seminar Telecommunications</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td>Project Seminar</td>
<td>6</td>
</tr>
</tbody>
</table>
**Module name**
Project Seminar Computer Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1040</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
</tr>
</tbody>
</table>

1. **Content**
Students elaborate on a research-oriented subject in the area of computer-systems. They present a written documentation and a presentation of the acquired advanced knowledge. They provide a set of alternative solutions to a given problem.

2. **Learning objectives / Learning Outcomes**
Students are able to systematically develop design alternatives to a given problem. They learn to acquire the necessary fundamental knowledge in terms of references and terminology.

3. **Recommended prerequisite for participation**
Basic knowledge of digital design

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
BSc ETiT, BSc/iST

7. **References**

 Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-1040-pj</td>
<td>Project Seminar Computer Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Christian Hochberger
Module name
Projektseminar Software Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1060</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language: German
Module owner: Prof. Dr. rer. nat. Andreas Schürr

1 **Content**
The course deals with various development and research topics in the area of model-driven engineering and object-oriented software engineering. Besides a general overview, it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics:

- Model-Driven Engineering and Model Synchronization
- Model Transformation
- Object-Oriented Refactorings
- Program Variability (Software Product Lines)
- Feature Model Analysis

Additional information and topic description for the current semester: [http://www.es.tudarmstadt.de/lehre/aktuelle-veranstaltungen/projektseminar-softwaresysteme/](http://www.es.tudarmstadt.de/lehre/aktuelle-veranstaltungen/projektseminar-softwaresysteme/)

2 **Learning objectives / Learning Outcomes**
The student gains practical experience in development (reengineering and maintenance) of complex software systems. He/She learns to work and function in a team, and to analyze and solve a non-trivial task. Moreover, students exercise using theoretical knowledge in the group (e.g. from lectures like software engineering – introduction / Design / Maintenance & Quality Assurance) to solve a concrete and practical problem.

Students that have successfully completed this seminar are able to independently organize and set-up a non-trivial software project and function to analyze and solve a certain task. Attendees gain the following skills in detail:

- realistic time and resource management (project management)
- experience with tools for version control and change management
- usage of CASE tools for model-based software development
- planning and execution of quality assurance measures

3 **Recommended prerequisite for participation**
Mandatory: Basic software technology knowledge and advanced knowledge of object-oriented programming languages

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
BSc ETiT, MSc ETiT, BSc iST

7 **References**
Each topic is covered by a specific selection of papers and articles.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-1060-pj</td>
<td>Projektseminar Software Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr. rer. nat. Andreas Schürr
# Module name
Project Seminar Terahertz Systems & Applications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1020</td>
<td>9 CP</td>
<td>270 h</td>
<td>210 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

## Language
German and English

## Module owner
Prof. Dr. rer. nat. Sascha Preu

## Content
Investigating and solving specific problems concerning the development of Terahertz devices and systems as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:
- Optics on chip
- Semiconductor devices
- Light-matter interaction

## Learning objectives / Learning Outcomes
After completion of the course, students possess:
- the ability to apply theoretical models to practical problems
- deep and special knowledge in a particular field related to THz science, optics or semiconductor physics
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise report, the ability to present and discuss achieved results in the form of a presentation in front of an audience

## Recommended prerequisite for participation
Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology

## Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

## Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

## Usability of this module
BSc ETiT, BSc Wi-ETiT, BSc/MSc iST

## References
Will be announced once the topic is defined

## Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-1020-pj</td>
<td>Project Seminar Terahertz Systems &amp; Applications</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
## 1.6 Project

### Module name
Subject-Advisor Introductionary Project

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-de-1050</td>
<td>3 CP</td>
<td>90 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language
German

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td></td>
</tr>
</tbody>
</table>

### Content
activating teaching; constructive feedback; active listening; fundamentals of developmental processes in project work / project management; define, formulate and communicate objectives; opportunities and risks of working in project teams

### Learning objectives / Learning Outcomes
After attending the course students are able to:
- give constructive feedback,
- active listening,
- formulate and communicate objectives, apply basic development methods and moderate them to project teams

### Recommended prerequisite for participation
Proof of competencies that are acquired in the module “Introductionary Project” (18-de-1010).
Proof of competencies that are acquired in the module "Electrical Engineering and Information Technology I" (18-ku-1070), "Electrical Engineering and Information Technology II" (18-hi-1010) or "Electrical Engineering and Information Technology Lab I" (18-wy-1040).
Successful participation in the selection process (personal interviews).

### Form of examination
Module final exam:
- Module exam (Study achievements, Special Form, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Special Form, weighting: 100 %)

### Usability of this module
BSc/MSc ETiT, BSc/MSc MEC, BSc Wi-ETiT, BSc/MSc iST

### References
Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-de-1050-pj</td>
<td>Subject-Advisor Introductionary Project (Project Week)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Product Development Methodology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1021</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Helmut Schlaak

1 Content
Practical experience in the methods used for the development of technical products. Work in a project team.

2 Learning objectives / Learning Outcomes
Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as part lists, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect.

3 Recommended prerequisite for participation
Parallel attendance of Proseminar ETiT Option MPE

4 Form of examination
Module final exam:
• Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
BSc ETiT, BSc WI-ETiT

7 References
Script: Development Methodology (PEM)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1021-pj</td>
<td>Product Development Methodology I</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Helmut Schlaak
## Module name
Product Development Methodology II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1021</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

### Language
German

### Module owner
Prof. Dr. Mario Kupnik

1. **Content**
   - Practical experiences by using methodical procedures in the development of technical products. In addition teamwork, verbal and written representation of results and the organization of development. Work in a project team and organize the development process independently.

2. **Learning objectives / Learning Outcomes**
   - Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as bills of materials, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect.

3. **Recommended prerequisite for participation**
   - Product Development Methodology I

4. **Form of examination**
   - Module final exam:  
     - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   - Module final exam:  
     - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   - BSc ETiT, BSc WI-ETiT, MSc MEC

7. **References**
   - Script: Development Methodology (PEM)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-1021-pj</td>
<td>Product Development Methodology II</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 1.7 Field Trip

<table>
<thead>
<tr>
<th>Module name</th>
<th>Excursion MPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-sl-1030</td>
</tr>
<tr>
<td>Credit Points</td>
<td>1 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>30 h</td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
</tr>
</tbody>
</table>

#### 1 Content
During the excursion MPE (duration 5 days) several companies working on electrical engineering and information technology and other fields will be visited. Students can become acquainted with close-to-reality examples. Working fields of an electrical engineer can be assessed, with technical- or organizational aspects and conditions of work as the main target. By the attendance of several companies in successive days, a comparison becomes possible. During the excursion the group is accommodated in e.g. hostels.

#### 2 Learning objectives / Learning Outcomes
Students should be able to understand products and the associated production processes and be able to concisely summarize this in a report.

#### 3 Recommended prerequisite for participation

#### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, pass/fail grading system)

#### 5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

#### 6 Usability of this module
BSc ETiT, BSc WI-ETiT

#### 7 References

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1030-ek</td>
<td>Excursion MPE</td>
<td>Field Trip</td>
<td>0</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 Master

2.1 Lecture

<table>
<thead>
<tr>
<th>Module name</th>
<th>Adaptive Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-zo-2010</td>
</tr>
<tr>
<td>Credit Points</td>
<td>6 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Self study</td>
<td>120 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language: German and English | Module owner: Prof. Dr.-Ing. Abdelhak Zoubir

1 Content

**Theory:**
1) Derivation of optimal filters for stochastic processes, e.g. Wiener filter or linear prediction filter based on suitable cost functions.
2) Elaboration of adaptive procedures, which allow to iteratively approach the optimal solution for non-stationary signals in non-stationary environments. Here, the adaptive procedures such as NLMS adaptation, affine projection, and the RLS algorithm are derived and extensively analysed.
3) Analysis of the adaptation behaviour and control procedures of adaptive filters based on the NLMS procedure.
4) Derivation and analysis of the Kalman filter as optimal filter for non-stationary input signals.
5) Procedures for the decomposition of signals into sub-bands for the realization of optimal filters in the frequency domain, e.g. noise reduction procedures.

**Applications:**
Parallel to the theory, practical applications are explained. As an example for the Weiner filter, the acoustic noise reduction procedures are explained. Acoustic echo cancellation and feedback cancellation are given as examples for adaptive filters. Furthermore beamforming approaches are introduced.
It is planned to offer an excursion to Siemens Audiology Engineering Group in Erlangen.
In the 4 to 5 exercises, some content of the lecture will be implemented in MATLAB which allows the students to get familiar with practical realizations of the theoretical procedures.

2 Learning objectives / Learning Outcomes

During the lecture, basics of adaptive filters are taught. The necessary algorithms are derived, interpreted and applied to examples of speech, audio and video processing.
Based on the content of the lecture you are able to apply adaptive filters to real practical applications.
For the admission to the exam you give a talk about a topic in the domain of adaptive filters chosen by you. This will allow you to acquire the know-how to read and understand scientific literature, familiarize yourself with an unknown topic and present your knowledge, such as it will be certainly required from you in your professional life as an engineer.

3 Recommended prerequisite for participation

Digital Signal Processing

4 Form of examination

Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading

Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module

MSc ETIT
7 References
Slides of the lecture.
Literature:
- E. Hänsler, G. Schmidt: Acoustic Echo and Noise Control, Wiley, 2004 (Textbook of this course);

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2010-vl</td>
<td>Adaptive Filters</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Henning Puder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2010-ue</td>
<td>Adaptive Filters</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Henning Puder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
Advanced Digital Integrated Circuit Design

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

#### 1 Content
- MOS Transistor Models, CMOS Logic Gates, Chip Layout and Design Rules, Static and Dynamic Behavior of CMOS Circuits, Synchronous CMOS Circuits, Performance and Power Characterisation, Design Techniques and CAD Tools, FPGA and Gate Array Technologies, Memory Technologies, Chip Test.

#### 2 Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to
- understand the short-channel effects of modern CMOS transistors,
- derive and analyse the most important circuit concepts for digital logic gates,
- understand the design flow of digital ASICs based on standard cells (design, layout, simulation/verification),
- knows the pros and cons of synchronous vs. asynchronous logic, multicycle systems,
- understands the differential design methods of integrated circuits (ASIC, ASIP, Full-custom/Semicustom, PLA, PLD, FPGA),
- understands basic circuitry of logic and arithmetic units (adders, multipliers, PLL/DLL),
- knows the design principles and properties of integrated semiconductor memory (DRAM, SRAM, Flash, MRAM, FeRAM)

#### 3 Recommended prerequisite for participation
Lecture “Electronics”

#### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

#### 5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

#### 6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC, MSc EPE

#### 7 References

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2010-vl</td>
<td>Advanced Digital Integrated Circuit Design</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Instructor
Prof. Dr.-Ing. Klaus Hofmann

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2010-ue</td>
<td>Advanced Digital Integrated Circuit Design</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Instructor
Prof. Dr.-Ing. Klaus Hofmann

2.1 Lecture
Module name
Advanced Power Electronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Gerd Griepentrog

1 Content
Switch mode power supplies (insulating DC/DC-converters) Realistic behavior of power semiconductors: Basics of semiconductor physics; Behavior of diode, bipolar transistor, SCR, GTO, MOSFET and IGBT, Important circuits for switching real semiconductors with low losses Forced commutation of SCRs, Loss reducing snubbers, quasi- resonant circuits, resonant switching. Topologies and control strategies for multilevel converter Thermal design and thermo mechanical aging of power electronics systems

2 Learning objectives / Learning Outcomes
After an active participation in the lecture, especially by asking all questions on topics which you did not fully understand as well by solving all exercises prior to the respective tutorial (i.e. not just shortly before the examination) you should be able to
1.) Explain und understand the cross sectional layers and the basic modes of operation for power semiconductors (diode, thyristor, GTO. Mosfet and IGBT). Describe the steady state and dynamic behavior of these devices.
2.) Identify the circuit diagrams for isolating DC/DC converters, especially for use in switched mode power supplies. Calculate the currents and voltages in these circuits using defined simplifications.
3.) Describe the functions of gate dive-circuits for ITGBTs.
4.) Calculate the thermal behavior and design the cooling equipment for a voltage source inverter equipped with IGBT modules.
5.) Describe the stress reliving circuits to reduce switching losses in IGBTs.
6.) Calculate the current and voltage characteristics in quasi-resonant and resonant circuits used in power electronics.
7.) Explain multilevel converters such as 3L-NPC and MMC
8.) Know the main concepts for cooling of power electronics incl. the ability to design a cooling concept and should know main aspects which influence lifetime

3 Recommended prerequisite for participation
BSc ETiT or equivalent, especially Power Electronics and Basics of Semiconductors

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc EPE, Wi-ETiT

7 References
Script available in Moodle for download
Literature:
• Mohan, Undeland, Robbins: Power Electronics: Converters, Applications and Design; John Wiley Verlag; New York; 2003
• Luo, Ye: “Power Electronics, Advanced Conversion Technologies”, Taylor and Francis, 2010

Courses

2.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2010-vl</td>
<td>Advanced Power Electronics</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-gt-2010-ue</td>
<td>Advanced Power Electronics</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Advances in Digital Signal Processing: Imaging and Image Processing

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2080</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Abdelhak Zoubir

1 Content
• Basics
  – Detection, Estimation and Classification

• Imaging
  – Radar Signal Processing
  – Array Signal Processing
  – Image formation
  – Applications of Imaging

• Image Processing
  – Random fields
  – Image segmentation
  – Image reconstruction
  – Image classification

• Project work

2 Learning objectives / Learning Outcomes
After attending the lecture, a student understands the basic principles of imaging systems with radar and sonar. He also is capable of applying image formation with sensor arrays as well as image processing techniques such as segmentation, image reconstruction and classification.

3 Recommended prerequisite for participation
DSP

4 Form of examination
Module final exam:
• Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc/MSc ETiT, MSc Wi/ETiT, BSc/MSc iST, MSc iCE, BSc/MSc MEC

7 References
• Mark Richards, Principles of Modern Radar: Basic Principles. SciTech Publishing 2010
• Didier Massonnet and Jean-Claude Souyris, Imaging with Synthetic Aperture Radar. EPFL Press, 2008
• Gerhard Winkler, Image Analysis, Random Fields and Markov Chain Monte Carlo Methods, 2nd edition, Springer Verlag 2003

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2080-vl</td>
<td>Advances in Digital Signal Processing: Imaging and Image Processing</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Dr.-Ing. Christian Debes
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2080-ue</td>
<td>Advances in Digital Signal Processing: Imaging and Image Processing</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Christian Debes</td>
</tr>
<tr>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Module name</td>
<td>Acoustics I</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-se-2010</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>3 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>90 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>60 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German</td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. (em.) Dr. Gerhard Sessler</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th><strong>Content</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Basic concepts of vibrations; impedance; electromechanical analogues,</td>
<td></td>
</tr>
<tr>
<td>2. sound field: wave equation; plane waves; sound absorption and dispersion; room absorption,</td>
<td></td>
</tr>
<tr>
<td>3. sound radiation: spherical, dipole, and cardioid source; linear arrays; circular piston membrane,</td>
<td></td>
</tr>
<tr>
<td>4. physiological and psychological acoustics: hearing organ; acoustic perception; speech production and speech intelligibility,</td>
<td></td>
</tr>
<tr>
<td>5. electroacoustic transducers; reciprocity relations; electrostatic, piezoelectric, electrodynamic, and other transducers; directional microphones; microphone calibration,</td>
<td></td>
</tr>
<tr>
<td>6. acoustic measuring methods: measurements of fundamental acoustic quantities; acoustic testing chambers; vibration measurements,</td>
<td></td>
</tr>
<tr>
<td>7. analogical and digital sound recording: digital and analogical disc and magnetic tape methods; movie sound,</td>
<td></td>
</tr>
<tr>
<td>8. ultrasound and hypersound: generation and detection; applications</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th><strong>Learning objectives / Learning Outcomes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>After completion of the lecture, students possess:</td>
<td></td>
</tr>
<tr>
<td>• the understanding of basic phenomena of generation, propagation, reception, storage and reproduction of sound;</td>
<td></td>
</tr>
<tr>
<td>• the ability to analyze acoustic components and systems;</td>
<td></td>
</tr>
<tr>
<td>• the ability to judge and design applications in the audio and ultrasonic frequency ranges.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th><strong>Recommended prerequisite for participation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Engineering I and II, Mathematics I to IV, Physics, Basics of Telecommunication</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th><strong>Form of examination</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Module final exam:</td>
<td></td>
</tr>
<tr>
<td>• Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th><strong>Grading</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Module final exam:</td>
<td></td>
</tr>
<tr>
<td>• Module exam (Technical examination, Oral Examination, weighting: 100 %)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th><strong>Usability of this module</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc ETiT</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7</th>
<th><strong>References</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Courses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
<td>18-se-2010-vl</td>
</tr>
<tr>
<td><strong>Course name</strong></td>
<td>Acoustics I</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. (em.) Dr. Gerhard Sessler</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Lecture</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Applied Superconductivity

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bf-2030</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr. Oliver Boine-Frankenheim

1 Content
- Basics of electrical conductivity at DC and RF
- Kamerligh-Onnes experiment, Meissner effect
- Superconductor state diagram
- London equations, Typ I / II Superconductor
- Cooper pairs (briefly: BCS theory, GL theory)
- Flux quantization, Flux vortices
- AC superconductivity, two fluid model, RF cavities
- Cooper pair tunneling, Josephson junctions
- Metrology: SQUIDs, (quantum-) Hall effect
- Superconductor magnetization, Hysteresis, Bean's model
- Applications: Magnets in accelerator and medical technology, precision field and current measurements, energy engineering

2 Learning objectives / Learning Outcomes
The students obtain a phenomenological understanding of superconductivity, which enables them to apply superconductors in engineering practice. Starting from Maxwellian electrodynamics, superconductors are introduced as perfect conductors at zero frequency. Both their DC and AC properties are discussed. Theory shall be reduced as much as possible. Quantum mechanics is not a requirement for the course, however, simplified quantum mechanical models will be introduced. The focus of the lecture is put on applications, e.g. magnet technology or precision metrology.

3 Recommended prerequisite for participation
Electrodynamics (Maxwell’s equations)

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc WI-ETiT, MSc iCE, BSc/MSc CE

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bf-2030-vl</td>
<td>Applied Superconductivity</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Dr.-Ing. Uwe Niedermayer
Module Name
Antennas and Adaptive Beamforming

Module Nr.
18-jk-2020
Credit Points
6 CP
Workload
180 h
Self study
120 h
Duration
1
Cycle offered
WiSe

Language
English
Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Overview of most important antenna parameters types as well as their applications. Fundamental theories: Fourier transform for far-field pattern calculations, antenna modeling techniques, antenna synthesis methods, image theory, determination of field regions of line sources, of the average radiated power density and power, directivity and gain. Antennas as key elements in power budgets of radio links, introducing the effective aperture of an antenna, deriving the relation between gain and effective aperture. Array antennas are a key hardware for beamforming and smart antenna systems: fundamentals of phased-scanning arrays, non-uniformly excited, equally spaced linear arrays, multi-dimensional planar arrays and mutual coupling effects. Wire antennas: still the most prevalent of all antenna forms, relatively simple in concept, easy to construct, very inexpensive. Antenna radiation fields and antenna parameters for different types of antennas are derived from Maxwell’s equations, applied for aperture antennas (horns, lenses or reflector antennas) and printed antennas (microstrip-patch and coplanar-slot antennas) Some basic numerical calculation methods: integral equation methods in the time and frequency domain, physical optics and uniform theory of diffraction are briefly summarized and compared for antennas and scattering problems. Smart antennas in communication and radar systems, with focus on beam steering and adaptive beamforming.

2 Learning objectives / Learning Outcomes
Students will know basic antenna parameters: pattern, gain, directivity, half-power beamwidth, side-lobe level, efficiency and input impedance to compare, assess and evaluate different antennas for various applications and operating frequencies. The antenna field regions, reactive near-field, near-field and far-field, can be differentiated and the far-field pattern of an antenna can be determined from given current distributions along the antenna by using Fourier transformation or integral solutions with distributed ideal dipoles as basic elements (antenna analysis). To assess in general physical requirements, constrains and limitations of antennas, students can use fundamental antenna theory: impedance matching techniques, antenna modeling and far-field pattern analysis, antenna synthesis, image theory and fundamental limits of electrically small antennas. After being incorporated into the different adaptive beamforming techniques, the array theory enables the student to design antenna systems that are assembled of a certain number of separate elements, feeding network, beamforming network etc. for phased-scanning or smart antennas in communications and sensing. Moreover, students are able to determine, analyze and evaluate the most important classes of antennas in wireless technology for many applications, operating frequencies, desired requirements or practical constrains: (1.) wire-dipole antennas, (2.) planar antennas (microstrip, dipole and slot antennas), (3.) aperture antennas (horn antennas, parabolic reflector antennas, lens antennas, Cassegrain and Gregorian double-reflector configurations), (4.) broadband and frequency-independent antennas (V antennas, biconical antennas, helical antennas, spiral and log-periodic antennas).

3 Recommended prerequisite for participation
Fundamentals of Communications, Microwave Engineering 1

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100%)

6 Usability of this module
BSc ETiT, MSc ETiT, MSc iCE, Wi-ETiT

7 References
Jakoby, Skriptum Antennas and Adaptive Beamforming, wird am Beginn der Vorlesung verkauft und kann danach im FG-Sekretariat erworben werden

| Courses |
|---------------------|---------------------|---------------------|---------------------|
| **Course Nr.**     | **Course name**     | **Type**            | **SWS**            |
| 18-jk-2020-vl      | Antennas and Adaptive Beamforming | Lecture            | 3                  |
| **Instructor**     | Prof. Dr.-Ing. Rolf Jakoby |                 |                    |
| **Course Nr.**     | **Course name**     | **Type**            | **SWS**            |
| 18-jk-2020-ue      | Antennas and Adaptive Beamforming | Practice         | 1                  |
| **Instructor**     | Prof. Dr.-Ing. Rolf Jakoby |                 |                    |
### Module name
Accelerator Physics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bf-2010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. Oliver Boine-Frankenheim</td>
</tr>
</tbody>
</table>

1 **Content**
Beam dynamics in linear- and circular accelerators, working principles of different accelerator types and of accelerator components, measurement of beam properties, high-intensity effects and beam current limits.

2 **Learning objectives / Learning Outcomes**
The students will learn the working principles of modern accelerators. The design of accelerator magnets and radio-frequency cavities will discussed. The mathematical foundations of beam dynamics in linear and circular accelerators will be introduced. Finally the origin of beam current limitations will be explained.

3 **Recommended prerequisite for participation**
BSc in ETiT or Physics

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc Physics

7 **References**
Lecture notes, transparencies

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bf-2010-vl</td>
<td>Accelerator Physics</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Oliver Boine-Frankenheim</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name
Acceleration of Charged Particles in Electromagnetic Fields

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kb-2010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

### Language

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Harald Klingbeil</td>
</tr>
</tbody>
</table>

### Content


### Learning objectives / Learning Outcomes

The lecture shows how different theories like electrodynamics, special relativity and nonlinear dynamics merge together in accelerator engineering for the motion of charged particles in electromagnetic fields. The student will get a good understanding of these theories, and he will be able to understand more advanced literature in the area of accelerator engineering and accelerator physics.

### Recommended prerequisite for participation

Vector analysis, infinitesimal calculus, basics in differential equations, first contact with Maxwell's equations.

### Form of examination

Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

### Grading

Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

### Usability of this module

MSc ETiT

### References

Lecture slides. List of textbooks.

### Courses

#### Course Nr. 18-kb-2010-vl

**Course name**
Acceleration of Charged Particles in Electromagnetic Fields

**Instructor**
Prof. Dr.-Ing. Harald Klingbeil

**Type**
Lecture

**SWS**
2

#### Course Nr. 18-kb-2010-ue

**Course name**
Acceleration of Charged Particles in Electromagnetic Fields

**Instructor**
Prof. Dr.-Ing. Harald Klingbeil

**Type**
Practice

**SWS**
2
Module name
Computer Vision in Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2090</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jürgen Adamy

1 Content

A Basics
- Scene Representation
- 2D and 3D Geometry
- Image Acquisition
  - Geometric Projections
  - Camera Calibration
- Objective and Illumination
- Discrete 2D signals
  - Separability, Sampling
  - Transformation, Interpolation
  - Convolution, Correlation
  - Discrete Fourier Transformation

B Basics of Image Analysis
- Filtering
  - Basics 2D Filter Design
  - Linear Filtering
  - Nonlinear Filtering
- Image Decompositions
  - Multi-scale Representation
  - Pyramids
  - Filter Banks
- Image Features
  - Structure
  - Moments, Histograms

2 Learning objectives / Learning Outcomes

The lecture communicates mathematical basics needed to solve computer vision problems in the field of engineering. The focus is on methods that are relevant for measuring and control tasks. Applications range from visual quality inspection, visual robotics, photogrammetry, visual odometry up to visually guided driver assistance etc.

The students should obtain a good understanding for the relations between the three-dimensional world and its two-dimensional projection onto the image plane of a camera. They also should learn about methods that exist to infer knowledge from the world given image data. They should develop some feeling for the different kinds of problems that arise in computer vision and how to choose an efficient solution in terms of algorithms.

3 Recommended prerequisite for participation

4 Form of examination

Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading

Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)
## References

References / Textbooks: Lecture slides, exercise sheets and matlab-code.

Further reading

- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2090-vl</td>
<td>Computer Vision in Engineering</td>
<td>Dr.-Ing. Volker Willert</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-ad-2090-ue</td>
<td>Computer Vision in Engineering</td>
<td>Dr.-Ing. Volker Willert</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Biomedical Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2050</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. Mario Kupnik

1 Content
Medical imaging: Introduction to 2D-x-ray imaging, x-ray tomography, magnet resonance imaging, nuclear and ultrasound imaging
Measurement procedures: Blood and brain pressure measurement, puls and oxygen saturation, biosignal acquisition with electrocardiography (ECG), electromyography (EMG) and electroenzophalography (EEG), bioelectrical impedance measurement, spirometric tests, ergometry, acoustical impedance of the airways, blood flow characterization with ultrasound doppler, application of micro sensors.

2 Learning objectives / Learning Outcomes
To list, compare and evaluate biomedical imaging and signal processing techniques, be able to describe current applications of medical measurements and to design a solution for a given task in this field.

3 Recommended prerequisite for participation
Bachelor ETiT

4 Form of examination
Module final exam:
  • Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
  • Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc WI-ETiT, MSc MEC

7 References
www.emk.tu-darmstadt.de/bmt/

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2050-vl</td>
<td>Biomedical Technology</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Dr.-Ing. Thorsten Meiß
### Module name
Circuit Building Blocks for Communication Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2190</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

#### 1 Content
Methods and Algorithms for the Circuit Implementations in communication systems

#### 2 Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to understand 1. the essential circuit building blocks of a communication system and able to describe them on transistor level, 2. Protocols and hardware-implementations of high-speed bus-systems, 3. Clock/data recovery techniques (DLL, PLL, Timing Recovery), 4. Aspects of error-detection and - avoidance.

#### 3 Recommended prerequisite for participation
Lecture “Advanced Digital Integrated Circuit Design” and “Hardware Description Languages:Verilog and VHDL”

#### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

#### 5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

#### 6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc MEC, MSc EPE

#### 7 References
Slide Copies

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2190-vl</td>
<td>Circuit Building Blocks for Communication Systems</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2190-ue</td>
<td>Circuit Building Blocks for Communication Systems</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name
Communication Technology II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language
English

**Module owner**
Prof. Dr.-Ing. Anja Klein

### Content
- linear and nonlinear digital modulation schemes, optimum receivers for AWGN channels, error probability, channel capacity, channel models, channel estimation and data detection for multipath channels, multicarrier schemes, OFDM

### Learning objectives / Learning Outcomes
After completion of the lecture, students possess:
- the ability of comparing, evaluating, classifying an analyzing linear and nonlinear modulation schemes by means of signal space representations;
- the ability to understand, describe and analyze the influence of AWGN on the signal;
- the ability to understand and derive optimum receivers in case of AWGN channels;
- the ability to understand, describe and analyze the influence of multipath propagation on the signal;
- the ability to describe the influence of a multipath channel mathematically (channel model) and estimate the multipath channel at the receiver;
- the knowledge of equalizing the received signal in order to undo the influence of multipath propagation, as well as the ability to derive and design several equalizer structures;
- the ability to analyze and evaluate the properties and application areas of multicarrier transmission systems, e.g. OFDM-systems;
- the ability to design and evaluate the system parameters of multicarrier schemes for the application in realistic mobile radio scenarios;

### Recommended prerequisite for participation
Electrical Engineering I and II, Deterministische Signale und Systeme, Stochastische Signale und Systeme, Communication Technology I, Basics of Telecommunication, Mathematics I to IV

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

### Usability of this module
MSc ETIT, MSc Wi-ETIT, MSc CE, MSc iCE, MSc iST, MSc MEC

### References
will be announced in the lecture

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2010-vl</td>
<td>Communication Technology II</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-kl-2010-ue</td>
<td>Communication Technology II</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Complex Network Dynamics: Theory and Applications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2090</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr. techn. Heinz Köppl

1 Content
The lectures cover major ideas of complex network theory, with emphasis on nonlinear dynamics and applications in real-world systems. This includes among others the basic theoretical issues such as traditional stability and Lyapunov exponents, bifurcations analysis and chaos. A focus is put on characterization of emergent collective behaviors when the elementary network blocks are coupled over various graphs. Analytical results are derived for the Kuramoto model of coupled phase oscillators and systems with inertia, also for coupled chaotic maps. More specifically, conditions for different types of synchronization and clustering are delivered including chimera states - as one of the most fascinating recent discovers in complex networks illuminating co-existence of synchronization and desynchronization. Applications of the presented models and theory will be shown from the areas of neuroscience, chemistry, optics, power grids, fluid dynamics, mechanical systems, and social systems. Finally, experimental evidence of the chimera states in various fields will be thoroughly discussed.

2 Learning objectives / Learning Outcomes
Students, who have successfully attended these lectures have acquired skills needed for theoretical and experimental analysis of various complex networks of coupled oscillators. This includes a deeper understanding of the following topics:
* nonlinear dynamics, bifurcations, and chaos
* synchronization in complex networks
* Kuramoto model, coupled map lattices
* application in real-world systems of coupled oscillators
* chimera states as a new trend of networks science.

3 Recommended prerequisite for participation
Basic knowledge of software engineering techniques, Matlab.

4 Form of examination
Module final exam:
• Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iST, MSc Wi-ETiT

7 References
http://www.bcs.tu-darmstadt.de/Courses

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2090-vl</td>
<td>Complex Network Dynamics: Theory and Applications</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2090-ue</td>
<td>Complex Network Dynamics: Theory and Applications</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1 Lecture
Module name
Computational Methods for Systems and Synthetic Biology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2080</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr. techn. Heinz Köppl

1 Content
The course covers mathematical methods used in the area of systems and synthetic biology. On the one hand it deals with practical modeling of molecular processes but also with theoretical investigations that reveal general properties of those processes. The course follows a microscopic approach and introduces those processes using probabilistic methods. For that, necessary prerequisites are recapitulated, such as definition of Markov processes in different spaces and their properties. With this background, the dynamics of stochastic reaction kinetics in terms of population models is investigated. Limiting cases are introduced, such as the diffusion approximation or the deterministic approximation (fluid approximations) of those systems. Often methods from statistical physics are applied. Numerical methods for solving the corresponding Fokker-Planck and Master equations are discussed. For the limiting case of a deterministic approximation, traditional methods for the stability analysis of nonlinear differential equations are introduced and methods are discussed that just rely on the topology of the reaction network to determine stability properties. In this context, a derivation of the moment dynamics and approximation methods based on moment closure are given. Connections to queueing theory models are shown.

Furthermore, the question is addressed of how the introduced dynamical models are calibrated to data from molecular biology. For that, general methods of statistical inference from statistics and of machine learning from computer science are discussed and specialized algorithms for the considered system class are presented. Additionally, a short introduction to the theory of nonlinear optimal filtering is given and special cases such as hidden Markov models are discussed.

Beyond reaction kinetics, the course provides a basic introduction to the modeling and numerical methods used in molecular dynamics. Newtonian multi-body simulations and classical potentials and their use in molecular dynamics are discussed. Most of the topics in this course are introduced through practical examples from applied modeling in the domain of systems biology. The applicability of the respective methods in synthetic biology is highlighted.

2 Learning objectives / Learning Outcomes
Students that successfully passed that course should be able to perform practical modeling of molecular processes and to determine dynamical properties of model using mathematical methods. It relies on the understanding of the following topics:

- Mathematical abstraction of molecular mechanisms
- General properties of stochastic processes
- Approximation methods for Markovian population models
- Stability analysis of nonlinear differential equations
- Numerical methods for solving/simulating stochastic systems
- System identification/machine learning for stochastic systems

3 Recommended prerequisite for participation
Basic knowledge of programming, Matlab.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iST, MSc Wi-ETiT, MSc MEC

7 References
## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2080-vl</td>
<td>Computational Methods for Systems and Synthetic Biology</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-kp-2080-ue</td>
<td>Computational Methods for Systems and Synthetic Biology</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Computer Aided Design for SoCs

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2200</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1 Content
CAD-Concepts for the design and simulation of integrated system-on-chips

2 Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to understand
- The most important design and verification abstractions as well as the design flow for the design of integrated electronic systems,
- Selected algorithms for optimization, simulation and solving of design tasks,
- Advanced methods for the design and simulation of analog integrated circuits in modern CMOS technologies,
- Advanced concepts of hardware description languages and their concepts (Verilog, VHDL, Verilog-A, Verilog-AMS, System-Verilog)

3 Recommended prerequisite for participation
Lecture "Advanced Digital Integrated Circuit Design" (can be attended in parallel) and „Analog Integrated Circuit Design“ and "Logic Design"

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iST, MSc MEC, MSc Wi-ETiT, MSc iCE

7 References
Slide Copies

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2200-vl</td>
<td>Computer Aided Design for SoCs</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2200-ue</td>
<td>Computer Aided Design for SoCs</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2200-pr</td>
<td>Computer Aided Design for SoCs</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Content Networking

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2140</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Ralf Steinmetz

1 Content
As the Internet has grown to become one of the most relevant information systems, so have the challenges associated with delivering static, streaming, and dynamic content to end-users. Communication infrastructures for the access and retrieval of content, so-called content networks, have proved to be crucial to meet the challenges. This lecture addresses the topic of content networking exclusively and comprehensively, tracing the evolution from traditional web caching to today's open and vastly more flexible architectures. The emphasis of the lecture is on the field's most persistent concepts, principles, and mechanisms—the core information that will help students in understanding why and how content delivery works.

2 Learning objectives / Learning Outcomes
Students attending the lecture will acquire knowledge on underlying ideas, concepts, and mechanisms, such as content caching as well as content switching and content routing. Little practical examples and experiments will help the students understand how basic techniques such as DNS and HTTP redirection are used in practical systems (e.g., Akamai, YouTube). Students will also be introduced to more advanced topics and recent trends in content networking, such peer-to-peer content delivery and content-centric networking. The ultimate goal of the lecture is to provide the students with an understanding of content networking and enable them to apply that knowledge in the future.

3 Recommended prerequisite for participation
At least completed Bachelor thesis or completed Studienarbeit

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc CS, MSc Wi-CS, MSc ETiT, MSc Wi-ETiT, MSc iST, MSc iCE

7 References
- Aktuelle Publikationen zu den verschiedenen Teilgebieten

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2140-vl</td>
<td>Content Networking</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Module name</td>
<td>Control of Drives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-gt-2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>5 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>150 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>90 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Gerd Griepentrog</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1 Content
- Control structures for drives; Design of controllers for drives; VSIs for drives; Space Vectors as basis of modelling AC-machines; Reference frames for description of AC-machines; Control oriented block diagram for DC-drive; Structure and design of the controllers;
- Control oriented block diagram for Permanent Magnet Synchronous Machine (PMSM); Control oriented block diagram for Induction machine (IM);
- Torque control for AC-machines using linear or switching controllers. Field Oriented Control and Direct Torque Control for PMSM and IM. Models and observers for rotor flux of IM;
- Speed control, including oscillatory load. Resolver and Encoder.

### 2 Learning objectives / Learning Outcomes
- After an active participation in the course including solving all exercises prior to the respective tutorial students should be able to:
  1.) develop the control-oriented block diagrams for the DC-machine operating in base speed range as well as in field weakening range.
  2.) design the control loops for 1.) concerning the structure and the control parameters.
  3.) Understand and apply space vectors and master their application in different rotating frames of reference.
  4.) Develop the dynamic equations of the permanent exited synchronous machine and the induction machine and to simplify these equations by help of suitable rotating reference frames and represent these equations as non-linear control-oriented block diagram.
  5.) Design the control loops according to 4.) especially the field-oriented control concerning the structure of the control loops and the control parameters.
  6.) Understand the deduction of equations given in the literature for machine types, which are not discussed in this lecture, e.g. for the doubly fed induction machine.
  7.) Derive the models and the observers for the rotor flux for the induction machine in different frames of reference and to apprise the benefits and drawbacks of the different solutions.
  8.) Design the control loops for the super-imposed speed controls even for mechanically oscillating loads.

### 3 Recommended prerequisite for participation
- BSc ETiT or equivalent, especially Control Theory and Electrical Machines / Drives

### 4 Form of examination
- Module final exam: (Technical examination, Written Examination, duration: 90 min, standard grading system)

### 5 Grading
- Module final exam: (Technical examination, Written Examination, weighting: 100 %)

### 6 Usability of this module
- MSc ETiT, MSc EPE, MSc MEC, Wi-ETiT

### 7 References
2.1 Lecture
Lecture notes, instructions for exercises are available in Moodle for download.

Literature:
- Mohan, Ned: “Electric Drives and Machines”
- De Doncker, Rik; et. al.: “Advanced Electrical Drives”
- Schröder, Dierk: “Elektrische Antriebe – Regelung von Antriebssystemen”
- Leonhard, W.: “Control of Electrical Drives”

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-gt-2020-vl</td>
</tr>
<tr>
<td>Instructor</td>
</tr>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-gt-2020-ue</td>
</tr>
<tr>
<td>Instructor</td>
</tr>
</tbody>
</table>
Module name
Digital Control Systems I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2020</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Ulrich Konigorski

1 Content
Theoretical fundamentals of sampled control systems:
Discrete-time functions, sample/hold element, z-transform, convolution sum, z-transfer function, stability of sampled systems, design of digital controllers, discrete PI-, PD-, and PID-controllers, compensation and dead-beat controller, anti-windup methods

2 Learning objectives / Learning Outcomes
The students know the fundamental analysis and design methods for digital feed-forward and feed-back control systems. They know the fundamental differences between continuous-time and discrete-time control systems and can design and analyze discrete-time control systems using different methods.

3 Recommended prerequisite for participation
Helpful is knowledge of the Laplace- and Fourier-transforms as well as continuous-time control systems. These fundamentals are taught in the lecture “System Dynamics and Control Systems I”

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc/MSc Wi-ETiT, MSc ETiT, BSc/MSc CE, MSc MEC, BSc/MSc iST, MSc iCE, MSc Informatik

7 References
Lecture notes Konigorski: “Digitale Regelungssysteme”
Ackermann: "Abtastregelung"
Aström, Wittenmark: "Computer-controlled Systems"
Föllinger: "Lineare Abtastsysteme"
Phillips, Nagle: "Digital control systems analysis and design"
Unbehauen: "Regelungstechnik 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme"

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2020-vl</td>
<td>Digital Control Systems I</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ulrich Konigorski

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2020-ue</td>
<td>Digital Control Systems I</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ulrich Konigorski
1 **Content**
State space description of discrete-time systems, controllability, observability, state feedback controller, pole assignment, PI-state feedback controller, discrete state observers, modified Luenberger observer

2 **Learning objectives / Learning Outcomes**
The students know the state space description of sampled control systems and the corresponding analysis and design methods. They can design deadbeat controllers, state feedback controllers by pole assignment and PI-state feedback controllers for single input systems and know how to implement state feedback controllers together with a discrete-time observer.

3 **Recommended prerequisite for participation**
Knowledge of the z-transform as well as the fundamentals of discrete-time control systems. These fundamentals are taught in the lecture "Digital Control systems I".

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc Wi-ETiT, BSc/MSc iST, MSc MEC, MSc iCE

7 **References**
Lecture notes Konigorski: “Digitale Regelungssysteme”
Ackermann: "Abtastregelung"
Åström, Wittenmark: "Computer-controlled Systems"
Föllinger: "Lineare Abtastsysteme"
Phillips, Nagle: "Digital control systems analysis and design"
Unbehauen: "Regelungstechnik 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme"

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2030-vl</td>
<td>Digital Control Systems II</td>
<td>Lecture</td>
<td>1</td>
</tr>
<tr>
<td>Instructors</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2030-ue</td>
<td>Digital Control Systems II</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructors</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Module name**
Digital Signal Processing

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2060</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr.-Ing. Abdelhak Zoubir

---

1. **Content**
   1) Discrete-Time Signals and Linear Systems – Sampling and Reconstruction of Analog Signals
   2) Digital Filter Design – Filter Design Principles; Linear Phase Filters; Finite Impulse Response Filters; Infinite Impulse Response Filters; Implementations
   3) Digital Spectral Analysis - Random Signals; Nonparametric Methods for Spectrum Estimation; Parametric Spectrum Estimation; Applications;
   4) Kalman Filter

2. **Learning objectives / Learning Outcomes**
   Students will understand basic concepts of signal processing and analysis in time and frequency of deterministic and stochastic signals. They will have first experience with the standard software tool MATLAB.

3. **Recommended prerequisite for participation**
   Deterministic signals and systems theory

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Written Examination, duration: 180 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Written Examination, weighting: 100 %)

6. **Usability of this module**
   BSc ETiT, Wi-ETiT

7. **References**
   Course manuscript
   Additional References:

---

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2060-vl</td>
<td>Digital Signal Processing</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-zo-2060-ue</td>
<td>Digital Signal Processing</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Real Time Applications and Communication with Microcontrollers and programmable Logic Devices

Module Nr. 18-gt-2040
Credit Points 4 CP
Workload 120 h
Self study 75 h
Duration 1
Cycle offered WiSe/SoSe

Language German
Module owner Prof. Dr.-Ing. Gerd Griepentrog

1 Content
Microcontroller and programmable logic devices are being used for a variety of control tasks for industrial and residential products and systems. For the control of drives and power electronics, those devices are used for the control of frequency converters or DC/DC converters. In most of these applications, real time requirements have to be met. Simultaneously a communication interface has to be served.

The module will impart knowledge and expertise on how to realize successfully control task. More in detail, the following content will be taught:

- Architecture of microcontroller
- Structure and function of FPGAs, tools and programming languages
- Typical peripheral components for microcontrollers
- Capture & Compare, PWM, A/D-converter
- I2C, SPI, CAN, Ethernet
- Programming of microcontrollers in C
- Software: real-time properties, interrupt handling, interrupt latency
- Control of inductive components
- Basic of circuit design for power electronics, Power-MOSFETS, IGBTs

2 Learning objectives / Learning Outcomes
Students will be able to:

- Separate a digital control task into HW and SW parts
- Specify the HW-content in a HW description language and implement the SW by means of a microcontroller
- Evaluate the real-time capabilities of a program and to determine upper limits for the response time of the system
- Transfer the developed solution to the target system by means of a development kit and debug the software onto the target system.

3 Recommended prerequisite for participation
Basic knowledge in programming language C (syntax, operators, pointer)

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc MEC, MSc ETiT

7 References
Script, Instruction for practical lab courses, ppt-Slides; either in hard-copy or for download; User Manuals of the used devices and development kits

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2040-vl</td>
<td>Real Time Applications and Communication with Microcontrollers and programmable Logic Devices</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr.-Ing. Gerd Griepentrog

**Type**  
Lecture  
SWS 1

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2040-pr</td>
<td>Real Time Applications and Communication with Microcontrollers and programmable Logic Devices</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr.-Ing. Gerd Griepentrog

**Type**  
Internship  
SWS 2
1 Content
The lecture basically covers a model-driven software engineering process which is specially customized for real-time systems. This process is more deeply explored in the exercise using an automotive example. A focus is laid on object-oriented techniques. In this context, the real-time specific CASE tool Rhapsody is introduced and used. Furthermore, fundamental characteristics of real-time systems and system architectures are introduced. Scheduling algorithms are discussed to get insights into real-time operating systems. Finally, a comparison between the Java programming language and its expansion for real-time operating systems (RT Java) will conclude the lecture.

2 Learning objectives / Learning Outcomes
Students, who have successfully attended this lecture have acquired skills needed for the model-driven and object-oriented development of embedded real-time systems. This includes a deeper understanding of the following topics:
- classification of real-time systems
- create and analyze executable models
- application of real-time scheduling algorithms
- evaluation and comparison of pros/cons of real-time programming languages as well as real-time operating systems

3 Recommended prerequisite for participation
Basic knowledge of software engineering techniques and excellent knowledge of at least one object-oriented programming language (preferably Java)

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, BSc IST, MSc Wi-ETiT, BSc Informatik

7 References
www.es.tu-darmstadt.de/lehre/es/

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2020-vl</td>
<td>Real-Time Systems</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-su-2020-ue</td>
<td>Real-Time Systems</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Electric Railways

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2140</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

Content
- Mechanics of traction
- Electrical part of traction vehicles
- Converter and motors for electrical traction
- Monitoring systems
- Comparison of different power supply systems
- DC- and AC- systems for light- and heavy rail
- Problems of earthing and earth return currents
- Sub stations, converters, power plants

Learning objectives / Learning Outcomes
Comprehension of the basic concepts of electric traction vehicles and power supply for electric railways

Recommended prerequisite for participation
Basic knowledge in electrical machines and drives

Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100%)

Usability of this module
MSc ETiT, MSc MEC, MSc Wi-ETiT

References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2140-vl</td>
<td>Electric Railways</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Harald Neudorfer
Module name
Power Systems II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2030</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jutta Hanson

1 Content
This lecture covers the essential aspects of the operation and analysis of power systems. The following topics will be covered:
- Operation of synchronous generators (steady-state operation, power chart, steady-state stability, transient stability, transient behavior)
- Calculation of short-circuit currents (Decaying three-phase short-circuit currents)
- Neutral grounding in MV- and HV-Systems (Systems with isolated neutrals, resonant grounding and solidly grounded neutrals)
- Network Protection

2 Learning objectives / Learning Outcomes
At the end of the lecture, the student should have a profound understanding of synchronous generator behavior, decaying short-circuit currents and their calculation and a basic understanding of neutral point treatment and network protection. The different types of power system stability are known.

3 Recommended prerequisite for participation
Knowledge comparable to “Energieversorgung I” or basic knowledge of power system equipment and calculations using symmetrical components.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc EPE, MSc Wi-ETiT

7 References
A script of the lecture, tutorials and past exams are available via Moodle.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2030-vl</td>
<td>Power Systems II</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2030-ue</td>
<td>Power Systems II</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Module name**
Power Systems III

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2080</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
</tr>
</tbody>
</table>

1 **Content**

System behaviour of innovative equipment in the Transmission System

Fields of application:
- Power transmission and voltage stability
- Ancillary services
- Power quality

Technology of innovative equipment:
- Power Electronics theory
- Motivation, technical realisation and operation / control of HVDC systems (LCC and VSC)
- Motivation, technical realisation and operation / control of power electronic devices for reactive power compensation (SVC, STATCOM, SC)
- Practical examples and outlook

2 **Learning objectives / Learning Outcomes**

After successful completion of this module, a student knows the driving forces for the utilisation of innovative equipment (HVDC, reactive power compensation) in power systems. He understands the system behaviour and operation of these devices and has realised the importance of modelling and simulation for safe and reliable design and operation.

3 **Recommended prerequisite for participation**

Contents of "Power Systems I"

4 **Form of examination**

Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 **Grading**

Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 **Usability of this module**

MSc ETiT, MSc MEC, MSc Wi-ETiT

7 **References**

Presentation slides

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2080-vl</td>
<td>Power Systems III</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr.-Ing. Jutta Hanson
**Module name**
Electromagnetic Compatibility

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2060</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
</tr>
</tbody>
</table>

1. **Content**
Fundamentals of Electromagnetic Compatibility, sources of emission, coupling mechanisms and counter measures, components for noise suppression, electromagnetic shields, EMC measuring and test techniques, excursion to VDE Offenbach

2. **Learning objectives / Learning Outcomes**
The students know that from every electromagnetic system a interaction is possible and that every electromagnetic (and also biological) system can be effected; they can differ between typical interference sources and sinks; they know the typical coupling paths und can identify and describe them mathematically; they know the basic methods to avoid interference at the source side and can derive their own actions against interference from this basic understanding; they know the basic actions to avoid interference at the sink side and can also derive actions to avoid interference; they have the ability to recognize coupling paths and can systematically influence or interrupt them completely; they know the situation of the EMC standardization and know basically which requirements have to be fulfilled and how to do this (also i.e. how to give a device a CE-label); they have learned the most important EMC testing and measurement techniques theoretically and practically know on the field trip.

3. **Recommended prerequisite for participation**
BSc

4. **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6. **Usability of this module**
MSc ETiT, MSc MEC, MSc Wi-ETiT

7. **References**
- All lecture slides (ca. 500 pcs.) available for download
- Adolf J. Schwab: Elektromagnetische Verträglichkeit, Springer-Verlag
- Clayton R. Paul: Introduction to Electromagnetic Compatibility, Wiley & Sons

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2060-vl</td>
<td>Electromagnetic Compatibility</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2060-ue</td>
<td>Electromagnetic Compatibility</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Electronic Sensors

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2020</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
</tr>
</tbody>
</table>

1 Content
- Introduction
- Measurement of temperature
- Optical measurements
- Magnetic effects
- Piezoresistive effect
- Piezoelectric effect
- Pyroelectric effect
- Measurement of chemical quantities
- Detectors for ionising radiation

2 Learning objectives / Learning Outcomes
- Classify the different types of measurement parameters, like temperature, pressure, field, etc.,
- differentiate which type of sensor should be used to measure certain parameters,
- analyse and understand the architecture and functionality of different sensor types, as well as
- independently designing simple measurement arrangements and
- gain comprehensive knowledge over the structural design of integrated in difference to discrete sensors.

3 Recommended prerequisite for participation
- Electrical Measuring Techniques
- Laboratory Measuring Techniques
- Microelectronic devices - the basics
- Electrical Engineering and Information Technology 1
- Electrical Engineering and Information Technology 2
- Laboratory ETiT 1
- Laboratory ETiT 2
- Mathematics 1
- Mathematics 2
- Introductory Physics

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC

7 References
- G. Schnell: Sensoren in der Automatisierungstechnik, ISBN 3-528-13370-8

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2020-vl</td>
<td>Electronic Sensors</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

2.1 Lecture
First the technical and economic importance of electrothermal processes will be pointed out. In addition to that, advantages, characteristics and applications of electroheat processes will be shown by typical examples.

The second part of the lecture is about thermotechnical and electrotechnical basics, which are necessary to understand electrothermal processes.

The main part of the lecture deals with examples of electrothermal processes, like induction heating (focus), conductive and dielectric heating as well as indirect resistance heating. Examples from industry are shown, and it will be explained how the applications are designed with numerical simulation tools (FEM-based) and analytical methods (calculation of electromagnetic fields).

At the end of the lecture special processes like laser applications will be shown.

Understanding of design and calculation of electrothermal processes and their applications

B.Sc. Electrical Engineering or Mechatronics

Module exam (Technical examination, Optional, weighting: 100%)

MSc ETiT, MSc MEC, MSc EPE, MSc Wi-ETiT


Course name

Electrothermal Processes

Type

Lecture

SWS

2
Module name
Power Cable Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2040</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1 Content
In the lecture, in addition to theoretical knowledge, also the practical side of high voltage cable technology will be treated. These are technical issues, e.g. water sensitivity of plastic cables, cable inspection, testing of already installed cables and the latest developments as in the field of superconductivity etc.. The contents of the lecture are:
- Cable construction: materials / requirements / design
- Cable Manufacturing: conductors / extrusion / shield / sheath (oil-paper insulation) / reinforcement
- Quality requirements and routine-/selection-/type- long term test / ISO 9001, standards, aging, endurance
- Cable junction technique: sockets / terminations / materials / field grading systems / cable connection
- Cable Systems: load / mech. requirements / ind. voltage / short circuit requirements / transient requirements / installation techniques
- Design and operation: route planning / laying / commissioning / monitoring / maintenance
- Trends: High-temperature superconductivity, Submarine cable, DC cable, forced cooling, GIL

2 Learning objectives / Learning Outcomes
Students learn the basic structure of a cable. They know the technical requirements both for the material and the design of a high voltage cable. The basics of manufacturing technology and the necessary tests are learned. The students are also able to evaluate new trends in cable technology.

3 Recommended prerequisite for participation
BSc. ETiT Electrical Power Systems

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT

7 References
Slides, literature sources

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2040-vl</td>
<td>Power Cable Systems</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Volker Hinrichsen
Module name
Regulation of Power Supply

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jutta Hanson

1 Content
- Structure of the German energy economy with focus on electrical power supply
- Changes in the regulatory framework (unbundling, grid regulation)
- Effects of the “Energiewende” on the energy economy in Germany
- Energy turnaround: technologies, energy balance
- Renewable energy law (EEG)
- Incentive regulation (“Anreizregulierung”)
- Excursion to Mainova AG

2 Learning objectives / Learning Outcomes
A student knows after successful completion of this module the basics, the driving forces and developments of the German energy economy. The effects of the German “Energiewende” and necessary technical changes for the energy sector are also taught.

3 Recommended prerequisite for participation
Good knowledge of content of the lecture “Energietechnik”

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc EPE, MSc Wi-ETiT, MSc MEC, MSc iST, MSc iCE, MSc CE

7 References
Lecture Notes

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2010-vl</td>
<td>Regulation of Power Supply</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Dipl.-Wirts-Ing. Ingo Jeromin
Module name
Energy Converters - CAD and System Dynamics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2010</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

1 Content
Design of cage-rotor and wound-rotor induction machines: Calculation of forces, torque, losses, efficiency, cooling and temperature rise. Transient machine performance of converter-fed dc machines and line-fed and inverter-fed ac machines. Theory is illustrated by examples: Sudden short circuit, load step, run up. For control design transfer functions of machines are derived. In the exercise lessons demonstration examples of power transformer and induction motor design are given. The students design one induction machine in small groups by themselves. Transient performance calculation is trained by using Laplace-Transformation and MATLAB.

2 Learning objectives / Learning Outcomes
With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to:

- do and explain the electromagnetic design of an induction machine both analytically and with use of computer program,
- understand and predict the thermal performance of electrical drives in a simplified way,
- calculate the instationary performance of separately excited DC drives
- to predict the dynamical performance of AC polyphase machines with space vector theory and use the MATLAB/Simulink package for this purpose.

3 Recommended prerequisite for participation
Bachelor of Science in Electrical Engineering, Power Engineering or similar

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC, MSc EPE

7 References
Detailed textbook and collection of exercises; Complete set of PowerPoint presentation
Vas, P.: Vector control of ac machines, Oxford Univ. Press, 1990

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2010-vl</td>
<td>Energy Converters - CAD and System Dynamics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------</td>
<td></td>
</tr>
<tr>
<td>18-bi-2010-ue</td>
<td>Energy Converters - CAD and System Dynamics</td>
<td></td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr. techn. Dr.h.c. Andreas Binder

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
## Module name
Evolutionary Systems - From Biology to Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2050</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

### Content
- Theory of biological evolution, introduction to genetics, population genetics, population growth, evolutionary algorithms, applications, DNA computing, artificial life, theory of evolutionary algorithms, optimization algorithms, multi-objective optimization, meta models, co-evolution, genetic coding, representations of evolutionary algorithms, developmental processes, self-adaptation, evolution and learning

### Learning objectives / Learning Outcomes
After attending the lecture, a student is capable of:
1. understanding the basic principles of evolutionary biology on a systems level,
2. transferring of this knowledge to the technical domain (evolutionary algorithms),
3. applying evolutionary algorithms to hard optimization problems,
4. gaining insight into the potentials and challenges of interdisciplinary research (natural and engineering/computer science).

### Recommended prerequisite for participation
Introductory courses mathematics. Basic computer skills.

### Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

### Usability of this module
MSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik, Biotechnik

### References
- D.J. Futuyama: Evolutionary Biology. W. Henning, Genetik, Springer Verlag;
- I. Rechenberg: Evolutionsstrategie '94;
- H.-P. Schwefel: Evolution and Optimum Seeking

### Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2050-vl</td>
<td>Evolutionary Systems - From Biology to Technology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. rer. nat. Bernhard Sendhoff</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Module name</td>
<td>Fuzzy Logic, Neural Networks and Evolutionary Algorithms</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-ad-2020</td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>75 h</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td></td>
</tr>
</tbody>
</table>

1 **Content**
Fuzzy systems: basics, rule based fuzzy logic, design methods, decision making, fuzzy control, pattern recognition, diagnosis; Neural networks: basics, multilayer perceptrons, radial basis functions, pattern recognition, identification, control, interpolation and approximation, Neuro-fuzzy: optimization of fuzzy systems, data driven rule generation; Evolutionary algorithms: optimization problems, evolutionary strategies and their applications, genetic programming and its applications

2 **Learning objectives / Learning Outcomes**
After attending the lecture, a student is capable of:
- recalling the elements and set-up of standardized fuzzy-logic, neural networks and evolutionary algorithms,
- discussing the pros and cons of certain set-ups of systems from computational intelligence for solving a given problem,
- recognizing situations in which tools taken from computational intelligence can be applied for problem solving,
- creating programs from algorithms taught in the lecture, and
- extending the learned standard procedures in order to solve new problems.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 **Usability of this module**
BSc iST, MSc ETiT, MSc MEC, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

7 **References**
Adamy: Fuzzy Logik, Neuronale Netze und Evolutionäre Algorithmen, Shaker Verlag (available for purchase at the FG office)
www.rtr.tu-darmstadt.de (optionales Material)

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2020-vl</td>
<td>Fuzzy Logic, Neuronal Networks and Evolutionary Algorithms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2020-ue</td>
<td>Fuzzy Logic, Neuronal Networks and Evolutionary Algorithms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
**Module name**
Large Generators and High Power Drives

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2020</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr. techn. Dr.h.c. Andreas Binder

1. **Content**
   Design of large electric generators: Special cooling methods with air, hydrogen and water, loss evaluation, especially eddy current losses, and measures to reduce the additional losses. Design of big hydrogenerators up to 800 MVA and turbo generators up to 2000 MVA with desing examples. Application of power electronics in large variable speed drives with synchronous motors: Synchronous converter and cyclo-converter. Numerous photographs to illustrate applications, excursion with students to special firms or plants.

2. **Learning objectives / Learning Outcomes**
   Expert knowledge in design of generators, large drives, their cooling systems and operational performance is acquired.

3. **Recommended prerequisite for participation**
   Physics, Electrical Machines and Drives, Electrical Power Engineering

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Optional, weighting: 100 %)

6. **Usability of this module**
   MSc EPE, MSc ETiT, MSc MEC, MSc WI-ETiT

7. **References**
   Detailed textbook with calculated examples; Vas, P.: Parameter estimation, condition monitoring, and diagnosis of electrical machines, Clarendon Press, 1993

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2020-vl</td>
<td>Large Generators and High Power Drives</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2020-ue</td>
<td>Large Generators and High Power Drives</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Railway Vehicle Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2050</td>
<td>3 CP</td>
<td>90 h</td>
<td>45 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

1 Content
From the comprehensive and interdisciplinary domain of the railway technology (vehicle technology, signal and safety technology, construction engineering and railway operating technology) the lecture picks out the domain of the automotive engineering with the emphasis of the mechanical part. It offers an interrelated introduction into selected chapters of the rail vehicle engineering with special emphasis in the railway-specific technical solutions and procedures. The lecture is divided into 7 chapters, whereby chapters 1-4 cover the theoretical basic topics and chapters 5-7 present the fundamental components of the rail vehicle. In a one-day excursion, it is possible to gain insights into the production of modern rail vehicles. Participation is voluntary.

2 Learning objectives / Learning Outcomes
Basic understanding of mechanical parts of railways and their components.

3 Recommended prerequisite for participation
Bachelor in Electrical Engineering, Mechatronics or Mechanical Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC, MSc EPE, MSc WI-ETiT

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2050-vl</td>
<td>Railway Vehicle Engineering</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Dr.-Ing. Gerd Meyer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2050-ek</td>
<td>Railway Vehicle Engineering (Excursion)</td>
<td>Field Trip</td>
<td>1</td>
</tr>
<tr>
<td>Dr.-Ing. Gerd Meyer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
High-Level Synthese

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2020</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Christian Hochberger

1 Content
- Mapping of behavioral descriptions (e.g. in the form of program fragments) on FPGA and CGRA structures
- Sub-tasks allocation, scheduling, binding
- Exact or heuristic solutions
- Design principles of heuristic solutions

2 Learning objectives / Learning Outcomes
Students that have completed this module know alternative approaches for all of the tasks of the high level synthesis and can select appropriate ones for specific applications. They can evaluate the memory and time complexity of the given algorithms. They are enabled to adapt the algorithms for new constraints and new target technologies.

3 Recommended prerequisite for participation
Knowledge of hardware synthesis on the basis of at least one hardware description language is required (e.g. Reese/Thornton: Introduction to Logic Synthesis Using Verilog Hdl oder Brown/Vranesic: Fundamentals of Digital Logic with VHDL Design). The student should have basic knowledge of at least one object oriented programming language, preferably Java.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, BSc/MSc iST, MSc iCE

7 References
English slides can be obtained through Moodle.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2020-vl</td>
<td>High-Level Synthese</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2020-ue</td>
<td>High-Level Synthese</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
Microwave Engineering II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2040</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

### Content
Block 1: Waveguides and resonators, 18 SWS (incl. exercises)
Block 2: Fundamentals of generation and detection of light and optical communication systems, 18 SWS (incl. exercises)
Block 3: Fundamentals of active microwave components, 18 SWS (incl. exercises)
Block 4: Preparation for the examination, min. 2 SWS

- Review of electromagnetic fundamentals: time-harmonic electromagnetic fields, boundary conditions; plane electromagnetic waves, reflection and transmission.
- Waveguides and resonators: rectangular waveguides, circular waveguides, stripline and microstrip lines, dielectric waveguides, resonators.
- Fundamentals of generation and detection of light and optical communication systems: laser, detectors, optical amplifiers, dispersion and attenuation, examples of optical communication systems.
- Fundamentals of active microwave components and circuits: Basic passive (distributed and lumped) and active (field effect transistors) building blocks of microwave circuit, Equivalent Circuits of Building blocks, S-Parameters, Basic Gain Principles, Microwave Circuit Aspects and Communication Applications.

### Learning objectives / Learning Outcomes
Students will gain knowledge on the physics of microwave waveguides and resonators, optical systems and active microwave components.

### Recommended prerequisite for participation
Introduction to Electrodynamics, Microwave Engineering I, Technical Electrodynamics

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

### Usability of this module
MSc ETiT, MSc iCE, Wi-ETiT

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2040-vl</td>
<td>Microwave Engineering II</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructors</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2040-ue</td>
<td>Microwave Engineering II</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructors</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
High Voltage Switchgear and Substations

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2020</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1 Content
This lecture covers the basic designs of high voltage substations as well as the design and working principles of high voltage switchgear:

- Types of switching and stresses induced by switching
- Arc behaviour in air, SF6 and vacuum
- Types of switchgear: earthing switches, disconnectors and circuit breakers
- Design and working principles of earthing switches and disconnectors in air and SF6
- Design and working principles of circuit breakers: vacuum breakers, pressured air and SF6 breakers (thermal blast and self-blast chambers)
- Stresses of earthing switches and disconnectors by short circuit conditions
- Testing of Switchgear
- Reliability of Switchgear
- Future developments: Intelligent control of switchgear, static switches, superconducting switchgear

2 Learning objectives / Learning Outcomes
The student should understand the purpose and working principles of high voltage switchgear as well as their usage in high voltage substations.

3 Recommended prerequisite for participation
Prior attendance of the lectures High Voltage Technology I and II is recommended.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 45 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, BSc/MSc iST, MSc Wi-ETiT, MSc EPE

7 References
A script of the lecture (in German) can be obtained from here: http://www.hst.tudarmstadt.de/index.php?id=30

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2020-vl</td>
<td>High Voltage Switchgear and Substations</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
High Voltage Technology II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1 Content
Layered Dielectrics, Methods of Field Control and Potential Control, Breakdown in Gases (air and SF6), Breakdown in Vacuum, Surface Discharges, Lightnings and Lightning Protection, Travelling Waves on Conductors; Excursion to a substation

2 Learning objectives / Learning Outcomes
The students are now able to optimize insulation systems also by choice of the dielectrics, by capacitive, refractive or resistive internal grading systems or by external geometrical/capacitive grading elements; they have understood why equipment is designed as it is and how and where it can or has to be optimized if requirements from service are changing; they have understood the physical phenomena behind the dielectric breakdown of gases and do know which are the main influencing parameters; they know the effect of strongly inhomogeneous electrode configurations and of extremely large gaps; they know the time dependencies of a dielectric breakdown and their impact on dielectric strength under impulse voltage stress; they are able to identify critical surface discharge configurations, know about the problems under severe external pollution of insulators and how to solve them; they are thus qualified to predict the dielectric strength of any electrode configuration under any kind of voltage stress and to design a particular required dielectric strength of equipment; they are particularly enabled to realize the demands of emerging UHV systems and to manage them; they have understood the mechanism of thunderstorms and lightning flashes and are able to derive protective measures for buildings, substations and overhead lines; they are skilled to calculate travelling wave effects and their effect on fast-front overvoltages and to develop adequate countermeasures.

3 Recommended prerequisite for participation
High Voltage Technology I

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT

7 References
- all lecture slides (ca. 460 pcs.) available for download
- Kind, Feser: High-voltage test techniques, SBA publications
- Kind, Kärner: High-voltage insulation technology, Vieweg

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2010-vl</td>
<td>High Voltage Technology II</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-hi-2010-ue</td>
<td>High Voltage Technology II</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Volker Hinrichsen

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
## Module name
Identification of Dynamic Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2040</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

## Content

1. **Introduction into the determination of mathematical process models based on measured data**
2. **Theoretical and experimental modeling of dynamic systems**
3. **System identification using continuous time signals:**
   - Aperiodic signals
     * Fourier analysis
     * Evaluation of characteristic values (stepresponses)
   - Periodic signals
     * Frequency response analysis
     * Correlation analysis

4. **System identification using discrete time signals:**
   - Deterministic and stochastic signals
   - Basics in estimation theory
   - Correlation analysis

5. **Parameter estimation techniques:**
   - Least-squares estimation
   - Model structure determination
   - Recursive estimation algorithms

6. **Kalman Filter and Extended Kalman Filter**
7. **Numerical Methods**
8. **Implementation under MatLab**
   Numerous examples with real experimental data

## Learning objectives / Learning Outcomes
The students are taught the fundamental methods in signal and system analysis. Furthermore, the students master methods such as Fourier analysis, correlation analysis and parameter estimation methods. Based on this foundation, the students are able to assess and to apply the individual methods and can derive non-parametric as well as parametric models from measured data.

## Recommended prerequisite for participation
MSc ETiT, MSc MEC

## Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

## Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

## Usability of this module
All disciplines of Electrical Engineering and Information Technology and similar disciplines (Mechatronics, Mechanical and Process Engineering, . . . ), Master of Science

## References

2.1 Lecture

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td>18-ko-2040-vl</td>
</tr>
<tr>
<td>18-ko-2040-ue</td>
</tr>
</tbody>
</table>
Module name
Industrial Electronics

<table>
<thead>
<tr>
<th>Module Nr. 18-ho-2210</th>
<th>Credit Points 4 CP</th>
<th>Workload 120 h</th>
<th>Self study 75 h</th>
<th>Duration 1</th>
<th>Cycle offered WiSe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Language</strong> German and English</td>
<td><strong>Module owner</strong> Prof. Dr.-Ing. Klaus Hofmann</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 **Content**

2 **Learning objectives / Learning Outcomes**
After successful completion of the module, students are able to: 1. understand the use of electronic components in typical industrial environments, 2. understand the function of the building blocks of typical IE components, 3. deeply understand the functioning of analog building blocks, 4. understand relevant field bus systems, 5. understand the regulatory and technical standards of industrial electronics components.

3 **Recommended prerequisite for participation**
Lecture “Elektronik” and “Analog IC Design”

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, M.Sc. iCE, M.Sc. MEC

7 **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr. 18-ho-2210-vl</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Dr.-Ing. Roland Steck</td>
<td></td>
</tr>
<tr>
<td>Type Lecture</td>
<td></td>
</tr>
<tr>
<td>SWS 2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr. 18-ho-2210-ue</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Dr.-Ing. Roland Steck</td>
<td></td>
</tr>
<tr>
<td>Type Practice</td>
<td></td>
</tr>
<tr>
<td>SWS 1</td>
<td></td>
</tr>
</tbody>
</table>
Module name
Information Theory II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
</tr>
</tbody>
</table>

1. **Content**
   This lecture course is devoted to advances of network information theory. Outline: overview of Shannon capacity, outage and ergodic capacity, capacity of channels with state, capacity of Gaussian vector channels, capacity regions of multi-user channels, capacity regions of multiple-access and broadcast fading channels, interference channel, relay channel, multiuser bounds, multi-user diversity, wiretap channel, secrecy rate and physical layer security.

2. **Learning objectives / Learning Outcomes**
   Students will understand advanced concepts and strategies in network information theory.

3. **Recommended prerequisite for participation**
   Knowledge of basic communication theory

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Optional, weighting: 100%)

6. **Usability of this module**
   MSc ETiT, BSc iST, MSc Wi-ETiT, MSc iCE, BSc/MSc CE

7. **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2010-vl</td>
<td>Information Theory II</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2010-ue</td>
<td>Information Theory II</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The course Communication Networks II covers the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

Topics are:
- Basics and History of Communication Networks (Telegraphy vs. Telephony, Reference Models, ...)
- Transport Layer (Addressing, Flow Control, Connection Management, Error Detection, Congestion Control, ...)
- Transport Protocols (TCP, SCTP)
- Interactive Protocols (Telnet, SSH, FTP, ...)
- Electronic Mail (SMTP, POP3, IMAP, MIME, ...)
- World Wide Web (HTML, URL, HTTP, DNS, ...)
- Distributed Programming (RPC, Web Services, Event-based Communication)
- SOA (WSDL, SOAP, REST, UDDI, ...)
- Cloud Computing (SaaS, PaaS, IaaS, Virtualization, ...)
- Overlay Networks (Unstructured P2P, DHT Systems, Application Layer Multicast, ...)
- Video Streaming (HTTP Streaming, Flash Streaming, RTP/RTSP, P2P Streaming, ...)
- VoIP and Instant Messaging (SIP, H.323)

Learning objectives / Learning Outcomes
The course Communication Networks II covers the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

Recommended prerequisite for participation
Basic courses of first 4 semesters are required. Knowledge in the topics covered by the course Communication Networks I is recommended. Theoretical knowledge obtained in the course Communication Networks II will be strengthened in practical programming exercises. So, basic programming skills are beneficial.

Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

Usability of this module
MSc ETiT, MSc iST, Wi-ETiT, CS, Wi-CS

References
Selected chapters from following books:

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Nr. 18-sm-2010-vl</td>
</tr>
<tr>
<td>Course name Communication Networks II</td>
</tr>
<tr>
<td>Instructor Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
<tr>
<td>Type Lecture 3</td>
</tr>
</tbody>
</table>

| Course Nr. 18-sm-2010-ue                    |
| Course name Communication Networks II       |
| Instructor Prof. Dr.-Ing. Ralf Steinmetz    |
| Type Practice 1                           |
Module name
Communication Networks IV

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2030</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Ralf Steinmetz

### 1 Content
The lecture communication networks IV deals with modelling and performance evaluation of computer networks and communication systems. The emphasis is on current analytical approaches. Owing to these methods a fundamental understanding of major performance related aspects in networking is achieved and basic knowledge for planning, optimization and advancement of communications networks is provided. The relevance and implications of individual theories are illustrated using examples which are drawn mainly from the Internet. Apart from analytical methods the lecture gives an introduction to simulation of communication networks as well as measuring in real or prototypical systems and testbeds. In addition to well-known methods and their applications selected aspects of current research questions will be elaborated on.

Topics of the lecture are:
- Introduction to performance evaluation and applications
- Leaky bucket traffic regulators, deterministic traffic models, deterministic and empirical envelopes
- Scheduling, generalized processor sharing
- Network calculus, min-plus systems theory, deterministic performance bounds
- Poisson processes, Markov-chains, classical queuing theory, $M|M|1$ and $M|G|1$ models
- Modeling of packet data traffic, self-similarity
- Effective bandwidths, moment generating functions, statistical multiplexing
- Statistical network calculus, effective envelopes, effective performance bounds
- Simulation, generation of random numbers, distributions, confidence intervals
- Instrumentation, measurements, bandwidth estimation in the Internet

### 2 Learning objectives / Learning Outcomes
Students attending this lecture obtain an overview on the impact, fundamental methods, and important applications of performance evaluation of communication networks. They are acquainted with characteristic mechanisms and scheduling algorithms used in quality of service networks and are able to explain their functionality in terms of network calculus and the framework of min-plus systems theory. In addition to basic queuing theory the students acquire sound knowledge of the theory of effective bandwidths and thus exhibit a theoretically founded understanding of statistical multiplexing. Beyond analytical methods, the students gain insight into simulation as well as selected measurement methods and tools used in real networks. They are able to define the scope of individual theories and methods, select suitable, problem tailored techniques, apply these to typical problems, and draw relevant conclusions.

### 3 Recommended prerequisite for participation
Basic courses of the first 4 semesters are required. Knowledge of lectures Communication Networks I and II are recommended.

### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

### 6 Usability of this module
Wi-CS, Wi-ETiT, BSc/MSc CS, MSc ETiT, MSc iST

### 7 References

2.1 Lecture
Ausgewählte Kapitel aus folgenden Büchern:

- Selected Journal Articles and Conference Papers

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2030-vl</td>
<td>Communication Networks IV: Performance Evaluation of Communication Networks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Convex Optimization in Signal Processing and Communications

Module Nr.  
18-pe-2020
Credit Points  
6 CP
Workload  
180 h
Self study  
120 h
Duration  
1
Cycle offered  
SoSe

Language  
English
Module owner  
Prof. Dr.-Ing. Marius Pesavento

1 Content
This graduate course introduces the basic theory of convex optimization and illustrates its use with many recent applications in communication systems and signal processing.
Outline: Introduction, convex sets and convex functions, convex problems and classes of convex problems (LP, QP, SOCP, SDF, GP), Lagrange duality and KKT conditions, basics of numerical algorithms and interior point methods, optimization tools, convex inner and outer approximations for non convex problems, sparse optimization, distributed optimization, mixed integer linear and non-linear programming, applications.

2 Learning objectives / Learning Outcomes
Students will learn the basic theory of convex optimization and its applications.

3 Recommended prerequisite for participation
Knowledge in linear algebra and the basic concepts of signal processing and communications.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 40 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2020-vl</td>
<td>Convex Optimization in Signal Processing and Communications</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-pe-2020-ue</td>
<td>Convex Optimization in Signal Processing and Communications</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>18-pe-2020-pr</td>
<td>Convex Optimization in Signal Processing and Communications Lab</td>
<td>Internship</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Power Plants and Renewable Energies

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2090</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jutta Hanson

1 Content
Forms of energy, Characteristics and figures of electricity industry, Importance of power generation – Energy Conversion in thermal processes (Carnot-Process), Categorization of power plants – Operation principle of steam power plants, gas power plants, water power plants, wind power plants, Use of solar energy (Photovoltaics, Solar thermal technology) and further regenerative energy sources (geothermal energy, biomass) – Technologies for Energy Converting and Storing (Power 2 X) – Electrical systems – Grid Connection for power plants

2 Learning objectives / Learning Outcomes
Goals are:
- Overview of concepts of power generation by various energy sources
- Comprehension of physical processes
- Operation principle and design of conventional and renewable power plants and storage
- Comprehension of electrical devices and control concepts

3 Recommended prerequisite for participation
Basics in Electrical Engineering, Power Engineering

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc WI-ET, MSc EPE, MSc MEC, MSc CE, MSc MB, MSc WI-MB

7 References
Script

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2090-vl</td>
<td>Power Plants and Renewable Energies</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2090-ue</td>
<td>Power Plants and Renewable Energies</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
Module name
Lighting Technology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Khanh Quoc Tran

1 Content
Structure and functionality of the human eye, terms and unit in lighting technology, photometry, radiometric and photometric properties of materials, filters, physiology of vision, colour theory, lighting, light sources. Measurement of luminous flux, luminous intensity, illuminance, luminance, determination of the spectral responsivity function of the human eye, colorimetry colour rendering, colour as traffic signals, measuring of optical material characteristics, LED properties

2 Learning objectives / Learning Outcomes
To list and connect terms, units and radiometric and photometric properties of materials in lighting technology, to describe and understand structure and functionality of the human eye and the physiology of vision, to illustrate basics of lighting, measuring methods and application. Being able to measure base items in lighting technology, applying knowledge of lighting and enhance them with experiments. Developing a better understanding for light and color.

3 Recommended prerequisite for participation
MSc ETiT, MSc Wi-ETiT, MSc MEC

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc MEC

7 References
Script for lecture: Lighting Technology I
Excersisebook: laboratory: lighting technology I

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2010-vl</td>
<td>Lighting Technology I</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2010-pr</td>
<td>Lighting Technology I</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>PD Dr.-Ing. Peter Zsolt Bodrogi</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Lighting Technology II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2020</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
</tr>
</tbody>
</table>

1 **Content**

2 **Learning objectives / Learning Outcomes**
To know current developments and applications, list and connect terms, to illustrate special topics of lighting, measuring methods and application. Being able to measure base items in lighting technology, applying knowledge of lighting and dedicated applications and further to enhance them with experiments. Developing a better understanding for light, color, perception and lighting situations.

3 **Recommended prerequisite for participation**
Lighting Technology I

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 **Usability of this module**
MSc ETiT, MSc Wi-ETiT, MSc MEC

7 **References**
Exercisebook: laboratory: lighting technology II

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2020-vl</td>
<td>Lighting Technology II</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2020-pr</td>
<td>Lighting Technology II</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Low-Level Synthese

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Christian Hochberger

1 **Content**
The module deals with synthesis steps on all abstraction layers below the register transfer level focusing on approaches suitable for FPGAs. At the logic level different types of minimization are explained (exact and heuristic two level minimizations, exact and heuristic multi level logic minimizations). The transition to the technology level is achieved by different decomposition and structural mapping techniques (FlowMap). Place&Route add geometric information to the technology mapped circuit. Analytical and heuristic placers are discussed (Simulated Annealing, Genetic Placers) and routing is illustrated through the PathFinder algorithm.

2 **Learning objectives / Learning Outcomes**
After completion of the module, students are enabled to investigate synthesis approaches for low level synthesis tasks. They can evaluate these approaches regarding their time and space complexity, as well as regarding their applicability to specific implementation technologies. Students can apply these approaches to new architectures and technologies.

3 **Recommended prerequisite for participation**
Knowledge of hardware synthesis on the basis of at least one hardware description language is required (e.g. Reese/Thornton: Introduction to Logic Synthesis Using Verilog Hdl oder Brown/Vranesic: Fundamentals of Digital Logic with VHDL Design). The student should have basic knowledge of at least one object oriented programming language, preferably Java.

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc iCE, MSc iST

7 **References**
A script of the lecture (in German) and English foils can be obtained from here: http://www.rs.tudarmstadt.de/

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2010-vl</td>
<td>Low-Level Synthese</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2010-ue</td>
<td>Low-Level Synthese</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name
Controller Design for Multivariable Systems in State Space

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2050</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language
German

### Module owner
Prof. Dr.-Ing. Ulrich Konigorski

### Content
- Pole assignment, Coupling and decoupling of linear multivariable systems, Optimal control, Design of state observers, Dynamic state feedback control, Structurally constrained state feedback

### Learning objectives / Learning Outcomes
The students will be able to analyse and design linear time-invariant multivariable systems by means of different state space design methods.

### Recommended prerequisite for participation
Basic knowledge of linear control theory ("System Dynamics and Control Systems I and II")

### Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

### Usability of this module
MSc ETiT, MSc MEC

### References
- Skript Konigorski: “Mehrgrößenregler im Zustandsraum”,
- Anderson, Moore: "Optimal Control: Linear Quadratic Methods",
- Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendung",
- Föllinger: "Optimale Regelung und Steuerung: Eine Einführung für Ingenieure",
- Roppenecker: "Zeitbereichsentwurf linearer Regelungen: Grundlegende Strukturen und eine Allgemeine Methodik ihrer Parametrierung",
- Unbehauen: "Regelungstechnik II: Zustandsregelungen, digitale und nichtlineare Regelungssysteme",

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2050-vl</td>
<td>Controller Design for Multivariable Systems in State Space</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-ko-2050-ue</td>
<td>Controller Design for Multivariable Systems in State Space</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Practice</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
High Voltage Measuring Techniques

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2050</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1 Content
1. Measurement of High DC Voltages
   1.1 Resistor Voltage Dividers
   1.2 Electrostatic Voltmeters
   1.3 Generating Voltmeters
   1.4 Rod/Rod Gaps
   1.5 DKD-Calibration of a 1500 kV-DC-Measuring System
   2.1 Inductive Voltage Transformers with Oil and with SF6-Insulation
   2.2 Capacitor Voltage Transformers
   2.3 Electronic Voltage Transformers
   2.4 Electro-Optical Voltage Transformers
   2.5 Calibration of Voltage Transformers
3. Measurement of High AC Voltages in the Laboratory
   3.1 Resistor Voltage Dividers
   3.2 Capacitor Voltage Dividers
   3.3 Measuring Sphere Gap
   3.4 Electronic Peak Voltmeter
   3.5 DKD-Calibration of a 1200 kV AC-Measuring System
4. Measurement of High Impulse Voltages
   4.1 Standard Impulse Voltages and their Normalized Amplitude Frequency Spectra
   4.2 Designs of R-, C- and RC-Dividers
   4.3 Computation of the Step Response of Impulse Voltage Dividers
   4.4 Analytical Calculation of the Response Time of a Divider with a Lead
   4.5 EMTP-Calculation of the Divider Output Voltage for Lightning Impulse Voltages
   4.6 DKD-Calibration of a 3 MV Lightning Impulse Measuring System
   4.7 DKD-Calibration of a 2 MV Switching Impulse Measuring System

2 Learning objectives / Learning Outcomes
The students learn the fundamentals, the dimensions, the application and the operation of voltage dividers up to 1.5 MV DC, 1.2 MV AC, 3.2 MV LI and 2 MV Si. They know and have understood the standards IEC 60060-2 High-Voltage Measuring systems and the Calibration Procedures of the German Calibration Service (DKD) for High-Voltage Measuring Systems which show that the uncertainty of the High-Voltage Measuring results of approved measuring systems are lower than the maximal permissible uncertainty for Type tests in an accredited High-Voltage Test Laboratory. They know, how the material of the resistors and the Isolationsystem influence the measuring uncertainty, the costs and the level of the maximal DC Voltage.

The students know and understand the equivalent circuits for power frequency of inductive and capacitive voltage transformer and are able to deduce the measuring errors and their dependency of the dimensioning of the magnetic and electric components.

The students learn and understand, why an ohmic resistor voltage divider in contrary to a capacitor voltage divider is not applicable for the measurement of high AC voltages. They are able to calculate the influence of the distance between a wall and the capacitor voltage divider with oil-paper insulation on the measuring error.

The students know, why capacitor voltage dividers without serious resistors are not applicable to the measurement of lightning impulse voltages. They can describe the advantages and the disadvantages of a low damped capacitor voltage divider as front capacitor of a lightning impulse voltage generator and as voltage divider. They know, why at LI-voltage measurements the test object must be situated between the generator and the divider. The students are able to reduce the interference of steep currents in the walls and in the ground of a high voltage test lab on the secondary voltage signal in the measuring cable from the divider to the recorder.

3 Recommended prerequisite for participation
BSc ETiT, BSc Wi-ETiT

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT

7 References
- VDE 0432: Hochspannungs-Prüftechnik: Teil 1: Allgemeine Begriffe und Prüfbedingungen; (2011-10) : 78 Euro
- VDE 0432: Hochspannungs-Prüftechnik: Teil 2: Messsysteme (2011-10) : 78 Euro
- Schon, K.: Stoßspannungs- und Stoßstrommesstechnik ISBN 978-3-642-13117-2; Springer Heidelberg; September 2010, 285 Seiten; 88 Euro

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2050-vl</td>
<td>High Voltage Measuring Techniques</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Dr. Ing. Wolfgang Breilmann
<table>
<thead>
<tr>
<th><strong>Module name</strong></th>
<th>Microprocessor Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-ho-2040</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>4 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>120 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>75 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>SoSe</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

1. **Content**
   Microprocessor Architectures, DSP Architectures and Hardware related Programming

2. **Learning objectives / Learning Outcomes**
   A student is, after successful completion of this module, able to
   1. gain the overview on the fundamentals of computer architecture and the different processor classes (RISC, CISC, Mikrocontroller, CPU, DSP),
   2. understand the central building blocks of a CPU
   3. understand the major properties of the required semiconductor memories, I/O blocks and data busses (USB, PCI, RS232),
   4. understand the most commonly used Interrupt- and Trap-handling algorithms,
   5. know the common software development methodologies for microcontrollers (assembler, pseudooperations, makros, subprograms and subroutines),
   6. understand the most important fundamentals of hardware oriented programming using C.

3. **Recommended prerequisite for participation**
   Basics of Computer Architectures

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Written Examination, weighting: 100 %)

6. **Usability of this module**
   MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC, MSc EPE

7. **References**
   Slide Copies

| **Courses** |
|----------------|----------------|
| **Course Nr.** | 18-ho-2040-vl |
| **Course name** | Microprocessor Systems |
| **Instructor** | Prof. Dr.-Ing. Klaus Hofmann |
| **Type** | Lecture |
| **SWS** | 2 |
| **Course Nr.** | 18-ho-2040-ue |
| **Course name** | Microprocessor Systems |
| **Instructor** | Prof. Dr.-Ing. Klaus Hofmann |
| **Type** | Practice |
| **SWS** | 1 |
### Module name
Micro Actuators and Small Motors

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2020</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
</tr>
</tbody>
</table>

1. **Content**
   Linear and rotating movements, action of force, actuators with mechanical and electronic commutation as well as alternating stator field, switched reluctance, stepping motors, micro actuators, piezoelectric motors and special actuators, gears. Measurement and control in actuation systems, choosing electrical actuators.

2. **Learning objectives / Learning Outcomes**
The educational objective of the course is to teach the students to independently design an actuation system in precision engineering. The students will be able to describe several actuator concepts and basic physical principles and optimally choose an actuator for a specific task.

3. **Recommended prerequisite for participation**
BSc ETiT

4. **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6. **Usability of this module**
MSc ETiT, MSc MEC, MSc WI-ETiT

7. **References**
Script for lecture: Small electromechanical actuators and motors

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2020-vl</td>
<td>Micro Actuators and Small Motors</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2020-ue</td>
<td>Micro Actuators and Small Motors</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Module name
Microsystem Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2040</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language
German

### Module owner
Prof. Dr.-Ing. Helmut Schlaak

### Content
Introduction and definitions to micro system technology; definitions, basic aspects of materials in micro system technology, basic principles of micro fabrication technologies, functional elements of microsystems, micro actuators, micro fluidic systems, micro sensors, integrated sensor-actuator systems, trends, economic aspects.

### Learning objectives / Learning Outcomes
To explain the structure, function and fabrication processes of microsystems, including micro sensors, micro actuators, micro fluidic and micro-optic components, to explain fundamentals of material properties, to calculate simple microsystems.

### Recommended prerequisite for participation
BSc

### Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

### Usability of this module
MSc ETiT, MSc MEC, MSc WI-ETiT

### References
Script for lecture: Mikrosystemtechnik

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2040-vl</td>
<td>Microsystem Technology</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2040-ue</td>
<td>Microsystem Technology</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Microwave Measurement Technologies

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2090</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Introduction to microwave measurement technologies, high frequency components and their properties: rf power measurement, spectrum analysis, vector network analysis (s-parameter, x-parameter, calibration techniques), on-wafer measurements, load/source-pull, material characterization

2 Learning objectives / Learning Outcomes
By this module, Students will be enabled to understand the basic principles of microwave measurement technologies. They are able to use them in measurement applications. The following objectives are linked to the lecture:

• The students understand the basic features of the power measurements and the effects of a mismatch or pulsed signals and can independently carry out and interpret measurements.
• The students understand the basics of spectrum analysis and can carry out and interpret measurements independently.
• The students understand the basics of s-parameter measurements and calibration of network analyzers and can carry out and interpret measurements independently.
• Students are familiar with various methods for material characterization

3 Recommended prerequisite for participation
Recommended: Grundlagen der Nachrichtentechnik, Hochfrequenztechnik I

4 Form of examination
Module final exam:
• Module exam (Technical examination, Oral Examination, duration: 45 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc etit, MSc WI-etit, MSc iCE, MSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2090-vl</td>
<td>Microwave Measurement Technologies</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-jk-2090-ue</td>
<td>Microwave Measurement Technologies</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-jk-2090-pr</td>
<td>Microwave Measurement Technologies Lab</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module name</td>
<td>MIMO - Communication and Space-Time-Coding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-pe-2030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>75 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**
   - This lecture course introduces the principles of space-time and multiple-input multiple-output (MIMO) communications.
   - Outline: Motivation and background; overview of space-time and MIMO communications; fading MIMO channel models, MIMO information theory; receive and transmit diversity; channel estimation, MIMO detectors, Alamouti space-time block code, orthogonal space-time block codes; linear dispersion codes; coherent and non-coherent decoders, differential space-time block coding; MIMO with limited feedback, Multiantenna- and multiuser diversity, BER performance analysis, MIMO in modern wireless communication networks, multicell and multiuser MIMO (coordinated multipoint).

2. **Learning objectives / Learning Outcomes**
   - Students will understand modern MIMO communications and existing space-time coding techniques.

3. **Recommended prerequisite for participation**
   - Knowledge of basic communication theory and basic information theory.

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Optional, weighting: 100%)

6. **Usability of this module**
   - MSc ETIT

7. **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2030-vl</td>
<td>MIMO - Communication and Space-Time-Coding</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-pe-2030-ue</td>
<td>MIMO - Communication and Space-Time-Coding</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

2.1 Lecture
Module name
Mobile Communications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2020</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Anja Klein

1 Content
The lecture covers aspects of mobile communication systems with particular focus on the physical layer. Mobile radio systems, services, market, standardization
duplex and multiple access techniques, cellular concept
mobile radio channel, deterministic and stochastic description
modulation schemes
code division multiple access (CDMA)
orthogonal frequency division multiplexing (OFDM)
optimum and suboptimum receiver techniques
 cellular radio capacity and spectrum efficiency
diversity methods
multiple input multiple output (MIMO) systems
power control and handover
architecture of mobile radio systems

2 Learning objectives / Learning Outcomes
After completion of the lecture, students possess
• a profound understanding of physical layer aspects, e.g., transmission schemes, multiple access schemes of mobile communication systems, duplex schemes, multi carrier schemes, receiver techniques, multi antenna schemes
• a profound understanding of signal propagation in mobile radio systems (mobile radio channel)
• the ability to understand and solve problems of the field of the physical layer
• the ability to compare, analyse and evaluate different system concepts
• knowledge on modelling of the transmission properties of the mobile radio channel

3 Recommended prerequisite for participation
Electrical Engineering I and II, Deterministic Signals and Systems, Communication Technology I, Mathematics I to IV

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETIT, MSc Wi-ETiT, MSc CE, MSc iCE, MSc iST, MSc MEC

7 References
will be announced in the lecture

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2020-vl</td>
<td>Mobile Communications</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

2.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2020-ue</td>
<td>Mobile Communications</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Anja Klein

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
### Module name
Modeling and Simulation

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

1. **Content**
   - aim of modeling, theoretical modeling by application of fundamental physical laws, generalized network analysis, modeling of distributed parameter systems, model reduction, linearization, order reduction, digital simulation of linear systems, numerical integration methods

2. **Learning objectives / Learning Outcomes**
   - The students will know different techniques for the mathematical modeling of dynamic systems from various domains. They will acquire the ability to digitally simulate the dynamic behavior of the modeled systems and to systematically apply the available numerical integration methods.

3. **Recommended prerequisite for participation**
   - Basic knowledge of continuous- and discrete-time control theory. Supplementary lectures are “System Dynamics and Control Systems I and II” as well as “Digital Control Systems I and II”.

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Optional, weighting: 100 %)

6. **Usability of this module**
   - MSc ETiT, MSc MEC

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2010-vl</td>
<td>Modeling and Simulation</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-ko-2010-ue</td>
<td>Modeling and Simulation</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

**Instructor**
- Prof. Dr.-Ing. Ulrich Konigorski
# Module name
Motor Development for Electrical Drive Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2032</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

## 1 Content
For the wide field of the drive technology at low and medium power range from 1 kW up to about 500 kW...1 MW the conventional drives and the current trends of developments are explained to the students. Grid operated and inverter-fed induction drives, permanent-magnet synchronous drives with and without damper cage ("brushless dc drives"), synchronous and switched reluctance drives and permanent magnet and electrically excited DC servo drives are covered. As a "newcomer" in the electrical machines field, the transversal flux machines and modular synchronous motors are introduced.

## 2 Learning objectives / Learning Outcomes
For the students who are interested in the fields of design, operation or development of electrical drives in their future career, the latest knowledge about
- modern computational methods (e.g. finite elements),
- advanced materials (e.g. high energy magnets, ceramic bearings),
- innovative drive concepts (e.g. transversal flux machines) and
- measurement and experiment techniques are imparted.

## 3 Recommended prerequisite for participation
Completed Bachelor of Electrical Engineering or equivalent degrees

## 4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

## 5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

## 6 Usability of this module
MSc ETiT, MSc MEC, not MSc EPE

## 7 References
A detailed script is available for the lecture. In the tutorials design of PM machines, switched reluctance drives and inverter-fed induction motors are explained.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2030-vl</td>
<td>Motor Development for Electrical Drive Systems</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2030-ue</td>
<td>Motor Development for Electrical Drive Systems</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
New Technologies of Electrical Energy Converters and Actuators

### Module Nr.
18-bi-2040

### Credit Points
4 CP

### Workload
120 h

### Self study
75 h

### Duration
1

### Cycle offered
SoSe

### Language
German and English

### Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

---

#### 1 Content
Goal: The application of new technologies, i.e. super conduction, magnetic levitation techniques and magneto-hydrodynamic converter principles, are introduced to the students. The physical operation mode in principle, implemented prototypes and the current state of the development are described in detail.

Content:
- Application of the superconductors for electrical energy converters:
  - rotating electrical machines (motors and generators),
  - solenoid coils for the fusion research,
  - locomotive- and railway transformers,
  - magnetic bearings.

- Active magnetic bearings (“magnetic levitation”):
  - basics of the magnetic levitation technique,
  - magnetic bearings for high speed drives in kW to MW range,
  - application for high-speed trains with linear drives.

- Magneto-hydrodynamic energy conversion:
  - physical principle,
  - state of the art and perspectives.

- Fusion research:
  - magnetic field arrangements for contactless plasma inclusion,
  - state of the current research.

---

#### 2 Learning objectives / Learning Outcomes
Basic knowledge in application of superconductivity in energy systems is understood as well as magnetic levitation, magnetohydrodynamics and fusion technology.

---

#### 3 Recommended prerequisite for participation
Physics, Electrical Machines and Drives, Electrical Power Engineering

---

#### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

---

#### 5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

---

#### 6 Usability of this module
MSc EPE, MSc ETiT, MSc MEC, MSc WI-ETiT

---

#### 7 References
Schmidt, E.: Unkonventionelle Energiewandler, Elitera, 1975

---

### Courses

2.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2040-vl</td>
<td>New Technologies of Electrical Energy Converters and Actuators</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-bi-2040-ue</td>
<td>New Technologies of Electrical Energy Converters and Actuators</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Module name</td>
<td>Optical Communications 2 – Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-ku-2070</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>4 CP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>120 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>75 h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>English</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 1 | **Content**                                                                 |
|   | Optical networks / structure, topology, layers                             |
|   | System design                                                               |
|   | Time division multiplexing, wavelength division multiplexing                |
|   | Modulation schemes for optical signals                                      |
|   | Transmission schemes                                                        |
|   | Dispersion compensation and management                                      |
|   | Signal characterization, performance parameters                              |

| 2 | **Learning objectives / Learning Outcomes**                                 |
|   | Students understand selected, advanced concepts of optical communications systems and their respective basics of physics, design criteria, limitations, and optimization. |

| 3 | **Recommended prerequisite for participation**                               |
|   | Optical Communications 1 – Components                                         |

| 4 | **Form of examination**                                                      |
|   | Module final exam:                                                           |
|   | • Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system) |

| 5 | **Grading**                                                                 |
|   | Module final exam:                                                           |
|   | • Module exam (Technical examination, Written Examination, weighting: 100 %) |

| 6 | **Usability of this module**                                                |
|   | MSc ETiT, MSc iCE, BEd                                                      |

| 7 | **References**                                                              |
|   | Lecture slides, textbook (M. Cvijetic, I. B. Djordjevic: „Advanced Optical Communication Systems and Networks“) |

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
</tr>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
</tr>
</tbody>
</table>
### Module name
Optical Communications 3 – Seminar WDM Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2080</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

1. **Content**
   - Building blocks and design of a high-bit rate transmission system
   - Experimental set-up
   - Characterizing components and signals by taking measurements
   - Simulation and optimization of the system
   - Presentation

2. **Learning objectives / Learning Outcomes**
   Students are able to design, to simulate, to optimize, to build, and to characterize an optical transmission system.

3. **Recommended prerequisite for participation**
   Optical Communications 2 – Systems

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100%)

6. **Usability of this module**
   MSc ETiT, MSc iCE

7. **References**
   Seminar slides, script, laboratory.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2080-se</td>
<td>Optical Communications 3 – Seminar WDM Lab</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

### Instructor
Prof. Dr.-Ing. Franko Küppers
Module name
Optical Technologies in Car Lighting

Module Nr. 18-kh-2041 Credit Points 4 CP Workload 120 h Self study 75 h Duration 1 Cycle offered Every 2. Sem.

Language German
Module owner Prof. Dr.-Ing. Khanh Quoc Tran

1 Content
History and standardisation of car lighting. Description of the oused lighting sources and the function of these (lowbeam, highbeam, bending light, stop lamp, daytime running light . . . ), visuell perception, glare, detection, traffic infrastructure, traffic elements, interior lighting, driver assistance systems (GPS, Radar, Lidar . . . )
Voluntary trip planed to an automobile manufacturer

2 Learning objectives / Learning Outcomes
To describe the basics and deepening knowledge of car lighting, understanding of the light distribution of head and rear lamps, to learn the basics of standardisation, enlarge glare and detection skills, know the traffic elements, as well as the driver assistance systems

3 Recommended prerequisite for participation
Lighting technology 1 (desireable)

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc WI-ETiT, MSc iST, MSc MEC, MSc MPE, MSc Physik

7 References
Lecture slides, Automotive Lighting and Human Vision, Handbuch Fahrrassistenzytstemene

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2041-vl</td>
<td>Optical Technologies in Car Lighting</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2041-pr</td>
<td></td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module name</td>
<td>Optoelectronics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-kh-2030-3 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>3 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>90 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>60 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**
   - Reflection, transmission, refraction, polarisation, formulae and quantities of radiation physics, semiconductor sensor, thermal sensor for optical applications, CCD and CMOS sensor, structure and measurement of digital cameras, basics of display technology, basics of LED-light generation, illumination with white LEDs, thermal behaviour of LEDs, optics with LEDs, fibre optics for illumination and data transfer, radiation generation with thermal and discharge lamps, radiation transport.

2. **Learning objectives / Learning Outcomes**
   - To illustrate laws of geometrical optics, to understand the fundamentals of optical radiation and radiometric quantities, to evaluate optical sensors and their basics, to apply optical light sources (LEDs and classic light sources), to understand and apply fibre optics and display technology.

3. **Recommended prerequisite for participation**
   - BSc ETiT, BSc MEC

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Oral Examination, weighting: 100%)

6. **Usability of this module**
   - MSc ETiT, MSc Wi-ETiT, MSc MEC

7. **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>18-kh-2030-192</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name</td>
<td>Optoelectronics</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
</tr>
<tr>
<td>Type</td>
<td>Lecture</td>
</tr>
<tr>
<td>SWS</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Photonic II - Concepts, Components, and Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2060</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Franko Küppers

1 Content
- Refreshing of mathematical background: harmonic oscillator equation, Fourier & Taylor expansions, and operators of vector algebra.
- Microscope and telescope.
- Fourier optics.
- Statistical optics.
- Semiconductor photon sources.
- Semiconductor photon detectors.
- Optical spectroscopy.
- Acousto-optics.
- Electro-optics.
- Ultrafast optics.
- Optical interconnects and switchers.
- Optical transmission systems.
- Optical amplifiers.
- Nanophotonics.

2 Learning objectives / Learning Outcomes
Students understand selected, advanced concepts and systems of photonics and their respective basics of physics, and can apply them to various, selected fields of natural and engineering sciences.

3 Recommended prerequisite for participation
Photonics I

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT

7 References
Lecture slides, textbook (will be announce at the start of every course semester)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2060-vl</td>
<td>Photonic II - Concepts, Components, and Systems</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2060-ue</td>
<td>Photonic II - Concepts, Components, and Systems</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module name</strong></td>
<td>Plasma Physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-bf-2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>3 CP</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>90 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>60 h</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German and English</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr. Oliver Boine-Frankenheim</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**
The lecture will cover the following topics:

2. **Learning objectives / Learning Outcomes**
The fundamental properties of plasmas, waves in plasmas as well as the interaction of electromagnetic fields with plasmas should be worked out and understood by the students during the course of this lecture.

3. **Recommended prerequisite for participation**

4. **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6. **Usability of this module**
MSc ETiT, MSc Physik

7. **References**
The transparencies can be downloaded from the TUCaN site.

<table>
<thead>
<tr>
<th><strong>Courses</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
<td>18-bf-2020-vl</td>
</tr>
<tr>
<td><strong>Course name</strong></td>
<td>Plasma Physics</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. Dr. Oliver Boine-Frankenheim</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Lecture</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
</tbody>
</table>
## Module name

Processor Microarchitecture

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2050</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

### Language

English

### Module owner

Prof. Dr.-Ing. Christian Hochberger

### Content

1. Lectures (each block takes 3 * 90 minutes)
   3. Execution in the micro-threaded pipeline. Interaction between cache controllers, register file, thread scheduler, integer pipeline. Data dependences between threads and its influence on execution (embarrassingly parallel vs. sequential programs). Interaction with legacy code, execution modes, OS support.
   5. Microthreading in multi-core architectures. Big issues: Scalability, sufficient parallelism, trade-off between clock frequency and access latency

Labs:

1. Set up the utgrlib VHDL sources in the home directory. Set up the utbinutils in the home directory. Compilation of introductory examples.
   10.-15. Integration of the block in UTLEON3, execution of micro-threaded programs, evaluation of performance analysis (% performance gain over the original block, % decreased resource requirements).

### Learning objectives / Learning Outcomes

After completion of the module, students will be able to design a customized microarchitecture of a modern RISC processor and analyze its performance.

The course will be taught using a VHDL implementation of an existing micro-threaded processor UTLEON3 in an FPGA, nevertheless the knowledge gained in the lecture will be applicable to other HDLs, different processor architectures and other implementation technologies.

### Recommended prerequisite for participation

Hands-on experience with at least one of Verilog or VHDL is expected. Basic understanding of FPGA technology and thorough knowledge of digital circuit design and computer architecture. Several tools used throughout the labs might require additional programming languages and tools (Perl, C, bash). This knowledge can be obtained during the labs.

### Form of examination

Module final exam:

- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

### Grading

Module final exam:

- Module exam (Technical examination, Oral Examination, weighting: 100%)

### Usability of this module

MSc ETiT, MSc iCE, MSc iST

### References

2.1 Lecture
A script is available as a published book and English slides can be obtained through moodle.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2050-vl</td>
<td>Processor Microarchitecture</td>
<td>Ph.D. Martin Danek</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-hb-2050-pr</td>
<td>Processor Microarchitecture</td>
<td>Ph.D. Martin Danek</td>
<td>Internship</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Multimedia Communications Project II

Module Nr.  
18-sm-2130  
Credit Points  
9 CP  
Workload  
270 h  
Self study  
180 h  
Duration  
1  
Cycle offered  
WiSe/SoSe

Language  
German and English  
Module owner  
Prof. Dr.-Ing. Ralf Steinmetz

1 Content
The course deals with cutting edge scientific and development topics in the area of multimedia communication systems. Besides a general overview it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics:

- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia / e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Resource-based Learning

2 Learning objectives / Learning Outcomes
The ability to solve and evaluate technical and scientific problems in the area of design and development of future multimedia communication networks and applications using state of the art scientific methods shall be acquired. Acquired competences are:

- Searching and reading of project relevant literature
- Design of complex communication applications and protocols
- Implementing and testing of software components for distributed systems
- Application of object-oriented analysis and design techniques
- Acquisition of project management techniques for small development teams
- Systematic evaluation and analyzing of technical and scientific experiments
- Writing of software documentation and project reports
- Presentation of project advances and outcomes

3 Recommended prerequisite for participation
Keen interest to develop and explore challenging solutions and applications in cutting edge multimedia communications systems using scientific methods. Further we expect:

- Solid experience in programming Java and/or C# (C/C++).
- Solid knowledge in object oriented analysis and design.
- Basic knowledge of design patterns, refactoring and project management.
- Solid knowledge in computer communication networks is recommended.
- Lectures in “Communication Networks I” and “Communication Networks II” are recommended

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
7 References

Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Erich Gamma, Richard Helm, Ralph E. Johnson: "Design Patterns: Objects of Reusable Object Oriented Software" (ISBN 0-201-63361-2)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2130-pr</td>
<td>Multimedia Communications Project II</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td>Internship</td>
<td>6</td>
</tr>
</tbody>
</table>

2.1 Lecture
### Module name
Process Control Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2030</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

1. **Content**
   - control systems, field bus, networks, programmable logic controller IEC 1131, asset management, OPC, plant information management (PIMS), man machine interaction

2. **Learning objectives / Learning Outcomes**
   - After attending the project course, a student is capable of:
     - gaining an overview of the field of process control engineering,
     - using the taught basic knowledge in IEC 1131 programming,
     - explaining the set-up of plant information management systems and man machine interaction

3. **Recommended prerequisite for participation**
   - basic skills in control, software and computer technology

4. **Form of examination**
   - Module final exam:
     - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Technical examination, Optional, weighting: 100 %)

6. **Usability of this module**
   - MSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

7. **References**
   - Polke: Prozeßleittechnik

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2030-vl</td>
<td>Process Control Engineering</td>
<td>Dr.-Ing. Martin Hollender</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Computer Systems II

Module Nr. 18-hb-2030
Credit Points 6 CP
Workload 180 h
Self study 120 h
Duration 1
Cycle offered WiSe

Language German
Module owner Prof. Dr.-Ing. Christian Hochberger

1 Content
   • Configurable Technologies
   • FPGA architectures and properties
   • System-On-Chip, HW components, SW toolchain, support SW
   • Coarse grained reconfigurable architectures, PE architecture, Modulo scheduling

2 Learning objectives / Learning Outcomes
   After completion of the module, students know reconfigurable technologies as well as chip architecture that employ them (e.g. FPGAs and CGRAs). They can select an appropriate technology for a given specific application. They know the components a system-on-chip (SoC) consists of. Students can configure and program an application specific SoC. They can map simple applications to a CGRA and know the limitations and pitfalls of this mapping.

3 Recommended prerequisite for participation
   Thorough basic knowledge of digital circuits and computer architecture as can be obtained in the lectures “Logischer Entwurf” and “Rechnersysteme I”. Additionally, students should be able to write simple programs in the programming language C.

4 Form of examination
   Module final exam:
      • Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
   Module final exam:
      • Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
   MSc ETiT, MSc iST, MSc iCE, MSc Wi-ETiT

7 References
   The slides (in German) of the lecture can be obtained through moodle.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2030-vl</td>
<td>Computer Systems II</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>18-hb-2030-ue</td>
<td>Computer Systems II</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Christian Hochberger
<table>
<thead>
<tr>
<th>Module name</th>
<th>Robust Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-ko-2140</td>
</tr>
<tr>
<td>Credit Points</td>
<td>3 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>90 h</td>
</tr>
<tr>
<td>Self study</td>
<td>60 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Ulrich Konigorski

1. **Content**
   - Basics (SVD, norms, system representations)
   - Control design in the frequency domain
     - Expressing control tasks as H2 and Hinf optimization problems
     - Design of H2 and Hinf optimal controllers
   - Robust Control
     - Uncertainty representations (Additive und multiplicative uncertainties, multi model representations)
     - Analysis of robustness (Small-Gain-theorem, mu-analysis)
     - Robust control design in the frequency domain

2. **Learning objectives / Learning Outcomes**
The students are able to express control tasks as H2 and Hinf optimization problems, to represent uncertainties of a system in a suitable form and to design a controller which ensures robust stability and robust performance.

3. **Recommended prerequisite for participation**
Systemdynamik und Regelungstechnik I und II

4. **Form of examination**
Module final exam:
   - Module exam (Technical examination, Optional, standard grading system)

5. **Grading**
Module final exam:
   - Module exam (Technical examination, Optional, weighting: 100 %)

6. **Usability of this module**
MSc ETiT, MSc MEC

7. **References**
   - S. Skogestad, I. Postlethwaite, Multivariable Feedback Control, 2. Auflage, 2005, Wiley
   - O. Föllinger, Regelungstechnik, 11. Auflage, 2013, VDE Verlag

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2140-vl</td>
<td>Robust Control</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Ing. Eric Lenz</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
X-Ray Free Electron Lasers

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2110</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Herbert De Gersem

1 Content
Optical lasers cannot produce x-rays of photons and high-gain free-electron lasers (FELs) are being developed as extremely bright sources of x-ray radiation. The peak brightness of these facilities exceeds that of other sources by more than ten orders of magnitude. FELs produce hard x-ray beams with very high transverse coherence and femtosecond pulse length. These characteristics open up new areas of x-ray science, such as femtosecond time-domain spectroscopy etc.

In this course an overview of the basics of FEL physics is given. We start our discussion from basics principles of particle acceleration and synchrotron radiation, consider the electron motion in an undulator and explain the most important steps to derive the high-gain FEL model. The performance of the high-gain FEL in the linear and the non-linear regimes is considered.

The self-amplified spontaneous emission (SASE) option is introduced and characterized. We discuss new schemes for enhancing of the FEL performance. The theoretical considerations in the course are partially illustrated by the results of numerical simulations and experiments. The numerical algorithms are shortly discussed.

2 Learning objectives / Learning Outcomes
The student should understand the basics of physics of free electron lasers.

3 Recommended prerequisite for participation
Maxwell’s equations, integral and differential calculus, vector analysis

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iST, MSc iCE, MSc Wi-ETiT

7 References
The foils of the lecture will be available at: http://www.desy.de/~zagor/lecturesFEL
K. Wille, Physik der Teilchenbeschleuniger und Synchrotron- strahlungsquellen, Teuner Verlag, 1996.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2110-vl</td>
<td>X-Ray Free Electron Lasers</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>PD Dr. Igor Zagorodnov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-dg-2110-ue</td>
<td>X-Ray Free Electron Lasers</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>PD Dr. Igor Zagorodnov</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Fast Boundary Element Methods for Engineers

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2160</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Herbert De Gersem

1 Content
How to solve field problems numerically on the computer? The Boundary Element Method (BEM) has developed into an important alternative to domain-oriented approaches (like Finite Elements), ever since fast implementations are available. The BEM reduces the dimensionality of the problem and can easily take into account unbounded domains.

Starting from the representation formulas of Kirchhoff and Stratton-Chu boundary integral equations are derived. Next, their discretization by collocation and Galerkin methods is discussed.

The resulting fully populated matrices have to be compressed for practical applications, by Fast Multipole or Adaptive Cross Approximation methods.

Industrial examples for application of the BEM are considered, for instance acoustic and electromagnetic scattering problems, and thermal analysis. Programming homework will be assigned, to deepen the students' understanding of the contents.

2 Learning objectives / Learning Outcomes
Students will acquire a detailed understanding of Modeling and Simulation with BEM.

- Derivation: convert certain types of partial differential equations to boundary integral equations
- Discretization: obtain boundary element methods from boundary integral equations
- Compression: efficiently store and solve the resulting linear systems of equations
- Application: solve practical field problems in engineering, in the acoustic, electromagnetic and thermal domains

3 Recommended prerequisite for participation
Basic knowledge about numerical methods for the solution of partial differential equations (e.g., Finite Elements).

Basic knowledge about modelling and simulation in an application domain (e.g., acoustic domain: wave equation; electromagnetic domain: Maxwell's equations; thermal domain: heat equation).

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc MEC, MSc CE

7 References
O. Steinbach: Numerical Approximation Methods for Elliptic Boundary Value Problems
S. Rjasanow, O. Steinbach: The Fast Solution of Boundary Integral Equations

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2160-vl</td>
<td>Fast Boundary Element Methods for Engineers</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Stefan Kurz

2.1 Lecture
Module name
Sensor Array Processing and Adaptive Beamforming

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2060</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Marius Pesavento

1 Content
This lecture course introduces the principles of modern sensor array processing and adaptive beamforming. Outline: Motivation and background; applications, narrowband and wideband signal model
Direction-of-arrival estimation (DoA):
- traditional methods based on beamforming, super resolution methods, Maximum-Likelihood methods,
- Subspace based methods, MUSIC, ESPRIT, MODE, root-MUSIC, multidimensional source localization,
- beamspace processing, array interpolation, partly calibrated arrays, wideband DOA estimation, spatial smoothing, forward-backward averaging, redundancy averaging, correlated sources, minimum redundancy arrays, compressed sensing and sparse reconstruction based DoA estimation, performance bounds
Adaptive beamforming:

2 Learning objectives / Learning Outcomes
Students will standard and modern sensor array processing techniques for source localization and transmit/receive beamforming

3 Recommended prerequisite for participation
Knowledge in linear algebra.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
BSc / MSc etit, BSc / MSc WI-etit, MSc MEC, MSc iST, MSc iCE

7 References
  - Chapter 12 - Adaptive and Robust Beamforming, Sergiy A. Vorobyov, Pages 503-552
  - Chapter 14 - DOA Estimation Methods and Algorithms, Pei-Jung Chung, Mats Viberg, Jia Yu, Pages 599-650
  - Chapter 15 - Subspace Methods and Exploitation of Special Array Structures, Martin Haardt, Marius Pesavento, Florian Roemer, Mohammed Nabil El Korso, Pages 651-717
- Spectral Analysis of Signals, Petre Stoica, Randolph Moses, Prentice Hall, April 2005
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2060-vl</td>
<td>Sensor Array Processing and Adaptive Beamforming</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-pe-2060-ue</td>
<td>Sensor Array Processing and Adaptive Beamforming</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

2.1 Lecture
Module name
Sensor Signal Processing

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2130</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>Every 2. Sem.</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. Mario Kupnik

Content
The module provides knowledge in-depth about the measuring and processing of sensor signals. In the area of primary electronics, some particular characteristics such as errors, noise and intrinsic compensation of bridges and amplifier circuits (carrier frequency amplifiers, chopper amplifiers, Low-drift amplifiers) in terms of error and energy aspects are discussed. Within the scope of the secondary electronic, the classical and optimal filter circuits, modern AD conversion principles and the issues of redundancy and error compensation will be discussed.

Learning objectives / Learning Outcomes
The Students acquire advanced knowledge on the structure of modern sensors and sensor proximity signal processing. They are able to select appropriate basic structure of modern primary and secondary electronics and to consider the error characteristics and other application requirements.

Recommended prerequisite for participation
Measuring Technique, Sensor Technique, Electronic, Digital Signal Processing

Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc MEC

References
- Slide set of lecture
- Skript of lecture
- Textbook Tränkler „Sensortechnik“, Springer
- Textbook Tietze/Schenk „Halbleiterschaltungstechnik“, Springer

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2130-vl</td>
<td>Sensor Signal Processing</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. Mario Kupnik
Module name
Sensor Technique

<table>
<thead>
<tr>
<th>Module Nr. 18-kn-2120</th>
<th>Credit Points 4 CP</th>
<th>Workload 120 h</th>
<th>Self study 75 h</th>
<th>Duration 1</th>
<th>Cycle offered WiSe</th>
</tr>
</thead>
</table>

Language German

Module owner Prof. Dr. Mario Kupnik

1 Content
The module provides basic principles of different sensors and the necessary skills for proper application of sensors. In terms of measuring chain, the focus of the event is located in the forming of any generally non-electric variable in an electrically evaluable signal.
Resistive, capacitive, inductive, piezoelectric, optical and magnetic measuring principles are treated in the lectures, in order to convey measuring of important values such as force, torque, pressure, acceleration, velocity, and flow.
In addition to the phenomenological description of the principles and resulting technical description, it should be traced an understood the main elements of the primary and secondary electronic for each principle.
In addition to the measuring principles, the errors description will be treated.
Thereby in addition to static and dynamic errors also error in the signal processing and error analysis of the entire measuring chain will be discussed.

2 Learning objectives / Learning Outcomes
The Students acquire knowledge of the different measuring methods and their advantages and disadvantages. They can understand error in data sheets and descriptions interpret in relation to the application and are thus able to select a suitable sensor for applications in electronics and information, as well process technology and to apply them correctly.

3 Recommended prerequisite for participation
Measuring Technique

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc W1-ETiT, MSc MEC

7 References
- Slide set of lecture
- Script of lecture
- Textbook Tränkler „Sensortechnik“, Springer
- Exercise script

Courses

<table>
<thead>
<tr>
<th>Course Nr. 18-kn-2120-vl</th>
<th>Course name Sensor Technique</th>
<th>Instructor Prof. Dr. Mario Kupnik</th>
<th>Type Lecture</th>
<th>SWS 2</th>
</tr>
</thead>
</table>

| Course Nr. 18-kn-2120-ue | Course name Sensor Technique | Instructor Prof. Dr. Mario Kupnik | Type Practice | SWS 1 |

2.1 Lecture
Module name
Simulation and Modelling Techniques and Tools for Mobile Communication Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2060</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Anja Klein</td>
</tr>
</tbody>
</table>

1 Content
Introduction to simulators
Basics
- Probability theory
- Statistics
- General description of simulators (classification, models, components, management)

Mobile communication systems
- Introduction to mobile networks
- Structure of mobile networks
- Important elements of radio access networks (PHY, MAC, RRC)
- Core networks

Simulation of mobile networks
- Link Level (Structure, Wireless channel, Coding, Multi-antenna, Receivers, Imperfectness)
- System Level (Structure, Deployments, Channels, Multi-user, Multi-cell, Re-lays, Imperfectness)
- Packet Level (Structure, Queues, QoS, Protocols, Abstractions, Imperfectness)

Languages and Tools
- MATLAB
- C++ libraries
- OPNET
- NS-3

Standards

2 Learning objectives / Learning Outcomes
After this lecture, students are able to:
- Implement mobile network simulators
- Calibrate based on mobile network standards
- Transfer algorithm and standards descriptions towards mobile network simulators
- Understand the limitations of simulators

3 Recommended prerequisite for participation
Communication Technology, Signal Processing
Related to Communication Networks and Mobile Communication

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc iST, MSc iCE, MSc Wi-ET, MSc CE

7 References
Will be given in lecture (mostly online available)

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Nr.</strong></td>
</tr>
<tr>
<td>18-kl-2060-vl</td>
</tr>
</tbody>
</table>
Module name
Social Learning and Knowledge Sharing Technologies

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2310</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
</tbody>
</table>

1 Content
The lecture aims to establish foundational knowledge about the key technologies and system design aspects needed for modern web-based learning environments. This covers functionality for learning resource management, learner modeling, recommendation of appropriate resources, and adaptation of system behavior to learners needs. Beyond this, networking and knowledge exchange among peer learners, based on social media interactions, are vital aspects for modern learning environments.

1. Introduction, Theories and Systems for Learning and Knowledge Sharing: Learning and Founding Theories, Challenges for Learning and Knowledge Sharing in Communities using Social Systems
2. Data Structures for Learning and Knowledge Resources: Syntax and Representation, Structures, Resource Description, Repositories
3. Data Structures for Learner Models and Community structures: User Profiles, Knowledge Domain Models, Graph Theory esp. Tripartite Representation and Interaction Graphs
6. Cooperation Support: Community Mining, Human Recommender Systems, Social Network Analysis
7. Collaboration Support: Peer-Tutoring, Collaborative Tasks, CSCL Systems, Group Formation
10. Evaluation Methods: Metrics, Historical Data based Evaluation, Theories and Hypotheses Validation Methods, Formative and Summative Evaluation

2 Learning objectives / Learning Outcomes
After completion of the module, students will be able to analyze and design web-platforms for knowledge acquisition and learning in communities based on different design patterns and technologies. They will be able to decide on information representation (data level), design of functionalities (application level), and selection/configuration of algorithms to support platform users concerning challenges in the learning process. Students are capable to consider techniques of adaptation to learners needs and will know appropriate evaluation methods to measure the qualities and effects of web-platforms for social learning and knowledge sharing.

3 Recommended prerequisite for participation
Basic knowledge about software engineering methods, web technologies like HTML and CSS, and communication networks protocols.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc iST

7 References
English slides can be obtained through Moodle. References to chapters from textbooks or other sources will be offered for each content module as needed.

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-sm-2310-vl</td>
</tr>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-sm-2310-ue</td>
</tr>
</tbody>
</table>
# Module name

Software Defined Networking

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2280</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

## Language

German and English

## Module owner

Prof. Dr.-Ing. Ralf Steinmetz

## Content

The course deals with topics in the area of software defined networking:

- SDN Data Plane
- SDN Control Plane
- SDN Application Plane
- Network Function Virtualization
- Network Virtualization and Slicing
- QoS and QoE in Software Defined Networks

## Learning objectives / Learning Outcomes

Students will get a deep insight into Software Defined Networking as well as underlying technologies and applications.

## Recommended prerequisite for participation

Basic courses of the first 4 semesters are required. Knowledge of lectures Communication Networks I and II are recommended.

## Form of examination

Module final exam:

- Module exam (Technical examination, Optional, standard grading system)

## Grading

Module final exam:

- Module exam (Technical examination, Optional, weighting: 100%)

## Usability of this module

MSc ETiT, BSc/iST, MSc Wi-ETiT, CS, Wi-CS

## References

Textbooks as indicated.

Slides and paper copies as necessary.

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2280-vl</td>
<td>Software Defined Networking</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2280-ue</td>
<td>Software Defined Networking</td>
<td>Practice</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Software-Engineering - Maintenance and Quality Assurance

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language: German

Module owner: Prof. Dr. rer. nat. Andreas Schürr

1 Content
The lecture covers advanced topics in the software engineering field that deal with maintenance and quality assurance of software. Therefore, those areas of the software engineering body of knowledge which are not addressed by the preceding introductory lecture, are in focus. The main topics of interest are: software maintenance and reengineering, configuration management, static programme analysis and metrics, dynamic programme analysis and runtime testing as well as programme transformations (refactoring). During the exercises, a suitable Java open source project has been chosen as running example. The participants analyze, test and restructure the software in teams, each dealing with different subsystems.

2 Learning objectives / Learning Outcomes
The lecture uses a single running example to teach basic software maintenance and quality assuring techniques in a practice-oriented style. After attendance of the lecture a student should be familiar with all activities needed to maintain and evolve a software system of considerable size. Main emphasis is laid on software configuration management and testing activities. Selection and usage of CASE tool as well as working in teams in conformance with predefined quality criteria play a major role.

3 Recommended prerequisite for participation
Introduction to Computer Science for Engineers as well as basic knowledge of Java

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc iST, MSc Wi-ETiT, Informatik

7 References
www.es.tu-darmstadt.de/lehre/se_ii/

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2010-vl</td>
<td>Software-Engineering - Maintenance and Quality Assurance</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Instructor: Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2010-ue</td>
<td>Software-Engineering - Maintenance and Quality Assurance</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Instructor: Prof. Dr. rer. nat. Andreas Schürr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Software Product Lines – Concepts, Analysis and Implementation

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2090</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. rer. nat. Andreas Schürr

1 Content
The lecture covers fundamental topics in the field of software product lines for engineering and quality assurance of variant-rich software systems. The software product line approach is motivated by reviewing the limitations of recent software engineering approaches and the general concepts of software product line engineering are introduced. Thereupon, the different paradigms and techniques for the specification, analysis and implementation of software product lines are presented. After the lecture, the participants are able to evaluate the different approaches and to choose and apply for a given problem those techniques being appropriate for software product line development and quality assurance. In addition, a survey on recent research directions in software product line engineering is given. The main focus of the exercises is to get familiar with model-based specification and efficient testing techniques for software product lines.

2 Learning objectives / Learning Outcomes
The lecture uses concrete examples from different application domains as well as a comprehensive running example from the automotive domain to illustrate the fundamental techniques for the development and efficient quality assurance of variant-rich software systems. After successful attendance of the lecture a student is familiar with the major activities needed for planning and conducting software product line engineering. Main emphasis is laid on seamless, model-based development and quality assurance processes especially focussing on different testing strategies for software product lines. The participants gain comprehensive skills for the evaluation, selection and application of software product line engineering tools tailored to specific problem domains.

3 Recommended prerequisite for participation
Introduction to Computer Science for Engineers as well as basic knowledge of an object-oriented programming language.

4 Form of examination
Module final exam:
• Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iST, MSc Wi-ETiT, Informatik

7 References
http://www.es.tu-darmstadt.de/lehre/spl/

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2090-vl</td>
<td>Software Product Lines – Concepts, Analysis and Implementation</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Dr. rer. nat. Malte Lochau</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2090-ue</td>
<td>Software Product Lines – Concepts, Analysis and Implementation</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Dr. rer. nat. Malte Lochau</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Speech and Audio Signal Processing

Module Nr. 18-zo-2070 | Credit Points 4 CP | Workload 120 h | Self study 75 h | Duration 1 | Cycle offered WiSe
---|---|---|---|---|---

Language German | Module owner Prof. Dr.-Ing. Abdelhak Zoubir

1 Content
Algorithms of speech and audio signal processing: Introduction to the models of speech and audio signals and basic methods of audio signal processing. Procedures of codebook based processing and audio coding. Beamforming for spatial filtering and noise reduction for spectral filtering. Cepstral filtering and fundamental frequency estimation. Mel-filtering cepstral coefficients (MFCCs) as basis for speaker detection and speech recognition. Classification methods based on GMM (Gaussian mixture models) and speech recognition with HMM (Hidden markov models). Introduction to the methods of music signal processing, e.g. Shazam-App or beat detection.

2 Learning objectives / Learning Outcomes
Based on the lecture you acquire an advanced knowledge of digital audio signal processing mainly with the help of the analysis of speech signals. You learn about different basic and advanced methods of audio signal processing, to range from the theory to practical applications. You will acquire knowledge about algorithms such as they are applied in mobile telephones, hearing aids, hands-free telephones, and man-machine-interfaces (MMI). The exercise will be organized as a talk given by each student with one self-selected topic of speech and audio processing. This will allow you to acquire the know-how to read and understand scientific literature, familiarize with an unknown topic and present your knowledge, such as it will be certainly required from you in your professional life as an engineer.

3 Recommended prerequisite for participation
Knowledge about statistical signal processing is required (lecture „Digital Signal Processing“). Desired – but not mandatory – is knowledge about adaptive filters.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 20 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc iCE

7 References
Slides (for further details see homepage of the lecture)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2070-vl</td>
<td>Speech and Audio Signal Processing</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Henning Puder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2070-ue</td>
<td>Speech and Audio Signal Processing</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Henning Puder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
System Dynamics and Automatic Control Systems III

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

#### 1 Content
Topics covered are:
- basic properties of non-linear systems,
- limit cycles and stability criteria,
- non-linear control of linear systems,
- non-linear control of non-linear systems,
- observer design for non-linear systems

#### 2 Learning objectives / Learning Outcomes
After attending the lecture, a student is capable of:
- explaining the fundamental differences between linear and non-linear systems,
- testing non-linear systems for limit cycles,
- stating different definitions of stability and testing the stability of equilibria,
- recalling the pros and cons of non-linear controllers for linear systems,
- recalling and applying different techniques for controller design for non-linear systems,
- designing observers for non-linear systems

#### 3 Recommended prerequisite for participation

#### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 180 min, standard grading system)

#### 5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100 %)

#### 6 Usability of this module
MSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

#### 7 References
Adamy: Systemdynamik und Regelungstechnik III (available for purchase at the FG office)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2010-vl</td>
<td>System Dynamics and Automatic Control Systems III</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2010-ue</td>
<td>System Dynamics and Automatic Control Systems III</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
Technology of Microsystems Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>Every 2. Sem.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
</tr>
</tbody>
</table>

### 1 Content
Provide insights into the various production and processing methods in micro- and precision engineering and the influence of these methods on the development of devices and components.

### 2 Learning objectives / Learning Outcomes
To describe coating processes like powder coating, electrochemical and vacuum deposition and CVD. To explain manufacturing of glass components: glass production, optical components, glass fibres, glass ceramics. To describe microfabrication technologies: photolithography, etching, diffusion, silicon micromachining, LIGA. To report manufacturing of electronic assemblies/modules and surface mount technologies (SMT).

### 3 Recommended prerequisite for participation
Technology of Micro and Precision Engineering (recommended)

### 4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, duration: 30 min, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

### 6 Usability of this module
MSc ETiT, MSc MEC, MSc Wi-ETiT

### 7 References
Script for lecture: Technology of Microsystem Technology

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2010-vl</td>
<td>Technology of Microsystems Technology</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2010-ue</td>
<td>Technology of Microsystems Technology</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name

Ultra-Large Scale Integration Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2010</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
</tr>
</tbody>
</table>

### Content

1) Introduction
2) Basic material
3) Layer technology
4) Lithography
5) Etching techniques and cleaning
6) Doping processes
7) Metallisation
8) Structural design technology
9) Process control
10) Process integration
11) Simulation

### Learning objectives / Learning Outcomes

- knowledge about the various process steps to manufacture advanced integrated circuits
- knowledge about the semiconductor process technologies for fabrication of advanced CMOS
- understand semiconductor technology in later career, to apply this technology
- and develop systems within the rapidly changing semiconductor industry

### Recommended prerequisite for participation

Examinations passed: Microelectronic devices - the basics, Electrical Engineering and Information Technology 1, Electrical Engineering and Information Technology 2, Laboratory ETiT 1, Laboratory ETiT 2, Mathematics 1, Mathematics 2, Introductory Physics

### Form of examination

Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

### Grading

Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

### Usability of this module

MSc ETiT

### References

- Lecture slides
- Lecture notes in preparation
- Widmann, Mader, Friedrich: Technologie hochintegrierter Schaltungen, Springer Verlag
- S.M. Sze: VLSI Technology, McGraw-Hill

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2010-vl</td>
<td>Ultra-Large Scale Integration Technology</td>
<td>Lecture</td>
<td>3</td>
</tr>
</tbody>
</table>

2.1 Lecture
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2010-ue</td>
<td>Ultra-Large Scale Integration Technology</td>
<td>Prof. Dr. rer. nat. Udo Eugen Schwalke</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
**Module name**
Terahertz Systems and Applications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-2010</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr. rer. nat. Sascha Preu

1 **Content**
The lecture will give an overview of Terahertz applications, sources and detectors with the focus on continuous-wave Terahertz generation and detection with semiconductor-based devices. Terahertz detection and generation will be discussed in detail for two types of highly important devices: Schottky diodes (mixers, multipliers and rectifiers) and photomixers (photo-diode based and photoconductive). The exercise, where performance parameters of the discussed devices will be derived for experimentally relevant cases, will help to deepen the understanding. The last day will be used for a lab tour showing our measurements facilities and hands-on experiments.

2 **Learning objectives / Learning Outcomes**
After attending this lecture, the student has gained basic knowledge in the fields of THz generation, detection and applications of THz radiation:
- Working principle, spectra and limits of continuous-wave photomixers
- Working principle of Schottky diode mixers/multipliers and rectifiers in the THz range
- THz Applications

3 **Recommended prerequisite for participation**
Bachelor in Electrical engineering, Physics, or Material Science
Helpful: Basic knowledge in semiconductor physics, High frequency 1

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc iST, MSc iCE, MSc WI-ETiT

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-2010-vl</td>
<td>Terahertz Systems and Sensors</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pr-2010-ue</td>
<td>Terahertz Systems and Sensors</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. rer. nat. Sascha Preu</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Module name
Terrestrial and Satellite-based Radio Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2030</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Basic physical knowledge of wireless communications, including various satellite and terrestrial radio systems, in particular for broadcasting and multimedia applications, focus on European approaches for terrestrial- and satellite-based digital video broadcasting (DVB-T and DVB-S), ASTRA, EUTELSAT, but also generally systems for mobile satellite communications and satellite navigation, terrestrial broadcasting systems like DAB and DVB-T, point-to-multipoint radio access systems (LMDS, MMDS).

2 Learning objectives / Learning Outcomes
In addition to the lecture, any student has to prepare and carry out a small project (exercise) in groups of two to three students. Different problems of wireless communications and systems will be introduced at the beginning of the lecture. They can be chosen by the students. The solution of a given problem and the final results has to be presented by the whole group within 20 to 25 min per group and, in addition, a small written report of 2 to 5 pages or the slices of the presentation has to be hand over.

3 Recommended prerequisite for participation
Fundamentels of Communications: Modulation and Access Schemes, Coding

4 Form of examination
Module final exam:
  - Module exam (Technical examination, Oral Examination, duration: 50 min, standard grading system)

5 Grading
Module final exam:
  - Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
BSc ETiT, MSc ETiT, MSc iCE, Wi-ETiT

7 References
Ohmori, S. u.a.: Mobile Satellite Communications, Artech House, 1998,
Feher, K.: Digital Communications, Noble Publishing Corp., 1997,
Rappaport, Th. S.: Wireless communications, Prentice Hall, 1996,
Pratt, T., Bostian, Ch.: Satellite Communications, John Wiley & Sons, 1986,
Roddy, D.: Satellitenkommunikation, Hanser Verlag,
Kammyer, K.D.: Nachrichtenübertragung, 2. Aufl., B.G. Teubner, 1996,

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2030-vl</td>
<td>Terrestrial and Satellite-based Radio Systems</td>
<td>Lecture</td>
<td>3</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-jk-2030-ue</td>
<td>Terrestrial and Satellite-based Radio Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td><strong>Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
<td>Practice</td>
<td>SWS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Module name
Overvoltage Protection and Insulation Coordination in Power System

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2030</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Volker Hinrichsen

1 Content

- Introduction, basics and overview
- Determination of representative overvoltages
  - Origin and classification of overvoltages
  - Normal distribution of overvoltage probability and derivated variables
  - Operating voltage and temporary overvoltages
  - Slow front overvoltages
  - Fast front overvoltages
  - Characteristics of overvoltage protective devices
  - Operation and design of metal-oxide surge arresters
  - Travelling wave effect and protective distance of surge arresters
  - Representative voltage and overvoltages in the case of using surge arresters

- Determination of coordination withstand voltage
  - Insulation strength for different voltage shapes and geometric configurations (gap factors)
  - Performance criterion
  - Insulation coordination procedure

- Determination of required withstand voltage
  - General remarks
  - Atmospheric correction
  - Safety factor for internal and external insulations

- Standard withstand voltage and testing procedures
  - General remarks
  - Test conversion factors
  - Determination and verification of insulation withstand by type tests
  - Table of test voltages and required clearances

2 Learning objectives / Learning Outcomes
The student have understood the main procedures of insulation coordination based on the relevant IEC standard (and the main difference with related IEEE standard procedure) which leads to selection of the electric strength of equipment in relation to the voltages which can appear on the system. In addition, they have learned the origin of different type of overvoltages as well as the protection of equipment against them. The operation and design of surge arresters as an important instrument of insulation coordination in power systems have been understood. The theoretical knowledge about the procedure of insulation coordination has been confirmed and expanded by practical case studies. The students are finally be able to carry out the insulation coordination independently in any application.

3 Recommended prerequisite for participation
High Voltage Technology I and II

4 Form of examination
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 Usability of this module
MSc ETIT, MSc EPE, MSc Wi-ETIT

7 References
The related IEC standard can be borrowed during the lecture time. Lecture notes (in English) and other helpful materials can be downloaded from HST homepage: www.hst.tu-darmstadt.de.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2030-vl</td>
<td>Overvoltage Protection and Insulation Coordination in Power System</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-hi-2030-ue</td>
<td>Overvoltage Protection and Insulation Coordination in Power System</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
## Module name
Computational Electromagnetics and Applications II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

## Content
- Fundamentals of the Finite Element Method: weighted residuals, projection methods, variational formulations, weak formulations; Finite elements: definitions, classification, first order Whitney element complex, higher order elements; convergence and precision;
- Implementation details: data structures, matrix assembly, postprocessing of the solution;
- FEM application to electromagnetic problems: electrostatics, magnetostatics, stationary currents, quasistatics, wave propagation.

## Learning objectives / Learning Outcomes
Students will master the theoretical basics of finite element methods. They understand details regarding the implementation of the method for stationary and quasistationary fields. They can apply the finite element method in electrical engineering.

## Recommended prerequisite for participation

## Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

## Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

## Usability of this module
MSc ETIT

## References
- Lecture slides.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2010-vl</td>
<td>Computational Electromagnetics and Applications II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Module name</td>
<td>Computational Electromagnetics and Applications III</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-dg-2020</td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>3 CP</td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>90 h</td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>60 h</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German and English</td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**

2. **Learning objectives / Learning Outcomes**
   Students learn the theoretical basis of advanced simulation techniques for time dependent electromagnetic fields. Furthermore, the lecture mediates practical skills for the implementation, analysis and application of simulation codes for common problems of Electrical Engineering.

3. **Recommended prerequisite for participation**

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Oral Examination, weighting: 100%)

6. **Usability of this module**
   MSc ETiT

7. **References**
   Lecture slides, matlab scripts, various literature sources

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2020-vl</td>
<td>Computational Electromagnetics and Applications III</td>
</tr>
</tbody>
</table>

| Instructor       | Privatdozent Dr. rer. nat. Erion Gjonaj       |

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Simulation of beam dynamics and electromagnetic fields in accelerators

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2170</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Herbert De Gersem

1 Content

2 Learning objectives / Learning Outcomes
The lecture gives an overview on the numerical modeling of charged particle beams and electromagnetic fields in accelerators. Emphasis is given to the simulation of collective effects caused by space-charge and electromagnetic wakefields. The lecture targets master students focusing on different disciplines of electrical engineering and physics. These include the theory of electromagnetic fields, computational engineering as well as computational and experimental accelerator physics. The level is sufficient to provide a solid foundation for contemporary simulation methods for particle beams in accelerators. Furthermore, for experimental accelerator physicists, the lecture provides insight into the different simulation tools, their application, their advantages and also their pitfalls and ranges of validity. During the course, practical simulation examples referring to actual problems at DESY, GSI and the S-DALINAC will be presented.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 0%)

6 Usability of this module
MSc ETiT, MSc Physik

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2170-vl</td>
<td>Simulation of beam dynamics and electromagnetic fields in accelerators</td>
<td>Privatdozent Dr. rer. nat. Erion Gjonaj</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

2.1 Lecture
The lecture reviews the different levels of energy management. It then focuses on economic dispatch and discusses its different use cases like optimization of self-consumption, virtual power plants, electric vehicle load management or multi-modal neighborhood optimization. Relevant knowledge about the components to be controlled as well as the markets to be addressed is explained. After this introduction to economic dispatch’s application environment, the lecture focuses on the methods employed. The underlying mathematical formulations as different types of optimization problems (LP, MILP, QP, stochastic optimization) are reviewed. In parallel, a practical introduction to numerical optimization is given (descent algorithms, convergence, convexity, programming languages for the formulation of optimization problems). Moreover, an introduction into simple methods for the prognosis of future values (linear regression) is provided. All methodological learning is accompanied by hands-on exercises using the Matlab/Octave and the GAMS/AMPL software environments.

Students know the different use cases and formulations of economic dispatch. They have a basic understanding of the typically employed optimization methods and are able to judge the quality of the achieved results. Moreover, students are independently able to formulate (energy) optimization problems and solve them with the tool GAMS/AMPL.

Standard knowledge of linear algebra and multivariate analysis as well as basic knowledge in the use of Matlab/Octave is required. Knowledge of the modules „Kraftwerke & EE“ or „Energiewirtschaft“ is helpful but not necessary.

Module exam (Technical examination, Optional, weighting: 100 %)


---

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-st-2010-vl</td>
<td>Energy Management and Optimization</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-st-2010-ue</td>
<td>Energy Management and Optimization</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------</td>
<td>----------</td>
<td>-----</td>
</tr>
<tr>
<td>18-st-2010-pr</td>
<td>Energy Management and Optimization Lab</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1 Lecture
The analysis and interpretation of data becomes ever more important, also for engineers. Digitalization and Smart Grids are terms to describe a host of novel data-based services in the field of generation, distribution, consumption and marketing of (renewable) energy. The lecture presents the recent developments and their underlying principles of machine learning technology.

For a start we will describe the different problem settings of machine learning in a structured way (classification, regression, clustering, dimensionality reductions, time series models, ...) and present for each setting relevant applications from the energy sector (prediction of renewable energy or consumption in multimodal energy systems, fault detection and prediction, data visualization, robust investments decisions, customer analysis, probabilistic load flow, ...).

Thereafter we will briefly review necessary tools from optimization and probability theory, as well as introduce probabilistic graphical models. With these tools we will then study for each problem setting one or more machine learning algorithms in detail, together with use cases from the energy domain. Classic algorithms will be developed (e.g. linear regression, k-means, principal component analysis, ...) as well as modern ones (e.g. SVMs, Deep Learning, Collaborative filtering, ...). Practical exercise with Matlab will deepen the understanding and support student's active knowledge.

Students understand important machine learning problem settings and some key algorithms for each task. They know common applications thereof in the energy domain. Moreover, the students are able to apply and adapt those methods independently to new applications (not only from the energy domain).

Good knowledge of linear algebra and the foundations of numerical optimization (e.g. from the course 18-st-2010 Energieanagement & Optimierung)

Using Matlab for programming the practical examples should pose no difficulty. A block tutorial on the use of Matlab is offered as 18-st-2030 Matlab Grundkurs.

Module final exam

Module exam (Technical examination, Optional, weighting: 100 %)

MSc etit, MSc iST, MSc Wi-etit, MSc CE

A Géron: Hands on Machine Learning with scikit-learn and Tensorflow, 2017
Friedman, Hastie, Tibshirani: The elements of statistical learning, 2001
Koller, Friedmann: Graphical Models, 2009

Course Nr. Course name
18-st-2020-vl Machine Learning & Energy

Instructor
Prof. Dr. rer. nat. Florian Steinke

Type Lecture
SWS 2
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-st-2020-pr</td>
<td>Machine Learning &amp; Energy Lab</td>
<td>Prof. Dr. rer. nat. Florian Steinke</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>18-st-2020-ue</td>
<td>Machine Learning &amp; Energy</td>
<td>Prof. Dr. rer. nat. Florian Steinke</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>

2.1 Lecture
Module name
Machine Learning in Information and Communication Technology (ICT)

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2110</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr. techn. Heinz Köppl

1 Content
The module provides an introduction to the emerging field of machine learning from an engineering perspective. Important models and learning methods are presented and exemplified through problems from information and communication technology:

- Fundamentals of probability theory and multivariate statistics
- Taxonomy of machine learning problems and models (supervised, unsupervised, generative, discriminative)
- Regression and classification: theory, methods and ICT applications
- Dimensionality reduction, clustering and big data analytics: methods and application in communications and signal processing
- Probabilistic graphical models: categories, inference and parameter estimation
- Fundamentals of Bayesian inference, Monte Carlo methods, Bayesian non-parametrics
- Fundamentals of convex optimization: Solution methods and application in communications
- Approximate algorithms for scalable Bayesian inference; application in signal processing and information theory (e.g. decoding of LDPC codes)
- Hidden Markov models (HMM): Theory, Algorithms and ICT applications (e.g. Viterbi decoding of convolutional codes)
- High-dimensional statistics ("large p small n" setting), learning dependency structure in high-dimensional data, learning causality relations from observational data.
- Sparse estimation, random projections, compressive sensing: Theory and applications in signal processing
- Deep neural networks (deep learning): Models, learning algorithms, libraries and ICT applications

2 Learning objectives / Learning Outcomes
Students are able to interpret and categorize specific engineering problems from the ICT domain in terms of machine learning problems. They are able to reduce such problems to standard machine learning problems and are able to determine suitable solution methods for them. They are able to implement all necessary algorithms from scratch, but they are also familiar with the state-of-the-art libraries in machine learning. They are able to determine the involved computational complexity of a method and choose an appropriate solution algorithms based on application constraints. They are able to apply the acquired methods to other domains, such as data analysis in biomedical engineering, analysis of social network data, etc.

3 Recommended prerequisite for participation
Good command of Matlab (for instance knowledge from course 18-st-2030 Matlab Grundkurs) and engineering mathematics

4 Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100 %)

6 Usability of this module
MSc etit, BSc/MSc iST, MSc iCE, MSc CE

7 References

2.1 Lecture
- Peter Bühlmann und Sara van de Geer. Statistics of high-dimensional data – Methods, theory and applications, Springer, 2011

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2110-vl</td>
<td>Machine Learning in Information and Communication Technology (ICT)</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-kp-2110-pr</td>
<td>Machine Learning in Information and Communication Technology (ICT) Lab</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>18-kp-2110-ue</td>
<td>Machine Learning in Information and Communication Technology (ICT)</td>
<td>Prof. Dr. techn. Heinz Köppl</td>
<td>Practice</td>
<td>1</td>
</tr>
</tbody>
</table>
2.2 Internships

Module name
Advanced Integrated Circuit Design Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2120</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Klaus Hofmann

1 Content
Practical Design Tasks in Full Custom Design of Digital or Analog Circuits using State-of-the-Art Commercial CAD Tools

2 Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to 1. develop and verify transistor circuitry using Cadence 2. simulate logic and analog circuits (Pre- and Postlayout) 3. draw, verify and extract layout

3 Recommended prerequisite for participation
Lecture “Advanced Digital Integrated Circuit Design” or “Analog Integrated Circuit Design”

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC, MSc EPE

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2120-pr</td>
<td>Advanced Integrated Circuit Design Lab</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Klaus Hofmann
**Module name**
Practical Training with Drives

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2100</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

1 **Content**
The purpose of this laboratory is gaining extented knowledge about realization and behaviour of drive systems. An introduction in measurement problems concerning drives is given. The contents of the laboratory is setting drives to work and investigating drive systems under laboratory conditions. Special attention is paid to inverter-fed AC drives. The laboratory experiments are individually coordinated with the previous knowledge of the respective courses (ETiT or MEC).

2 **Learning objectives / Learning Outcomes**
The students get the ability of measurement for electrical motors, generators and transformers.

3 **Recommended prerequisite for participation**
Bachelor of Science in Electrical Engineering, Power Engineering or similar

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc MEC, MSc WI-ETiT

7 **References**
Textbook with lab instructions;
Leonhard, W.: Control of electric drives, Springer, 2000;
Textbook – Binder, A.: Motor Development for Electrical Drive Systems; Lecture notes – Mutschler, P.: Control of Drives

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2100-pr</td>
<td>Practical Training with Drives</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2090-tt</td>
<td>Laboratory Briefing</td>
<td>Tutorial</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
</tr>
</tbody>
</table>

2.2 Internships
# Module name

**Power Laboratory I**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2091</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

## Language

German and English

## Module owner

Prof. Dr. techn. Dr.h.c. Andreas Binder

## Content

Safety instructions for laboratory;

**Topic of experiments:**

- Electrical energy conversion
- Power electronics
- High voltage technology
- Electrical energy supply
- Renewable energies

## Learning objectives / Learning Outcomes

Practical knowledge is gained in measuring and operating electrical devices and apparatus of electrical power engineering in small groups of students.

## Recommended prerequisite for participation

Power Engineering or similar

## Form of examination

Module final exam:

- Module exam (Study achievements, Written Examination, duration: 120 min, standard grading system)

## Grading

Module final exam:

- Module exam (Study achievements, Written Examination, weighting: 100%)

## Usability of this module

MSc ETiT, MSc MEC, MSc WI-ETiT

## References


Nasar, S.A.: Electric Power systems. Schaum's Outlines


## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2091-pr</td>
<td>Power Laboratory I</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr. techn. Dr.h.c. Andreas Binder

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2090-tt</td>
<td>Laboratory Briefing</td>
<td>Tutorial</td>
<td>0</td>
</tr>
</tbody>
</table>

**Instructor**

Prof. Dr. techn. Dr.h.c. Andreas Binder

---

2.2 Internships
Module name
Power Laboratory II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2092</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr. techn. Dr.h.c. Andreas Binder

1 Content
Practical course on power engineering - Distribution and Application. About 50% of the units are devoted to power distribution and high voltage engineering; About 50% are dealing with application in drive systems, concerning “field-oriented control” of variable speed drives, encoder systems, linear permanent magnet and switched reluctance machines.

2 Learning objectives / Learning Outcomes
Practical knowledge is gained in measuring and operating electrical devices and apparatus of electrical power engineering in small groups of students.

3 Recommended prerequisite for participation
Master program: Power Lab 1

4 Form of examination
Module final exam:
- Module exam (Study achievements, Written Examination, duration: 120 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC, MSc WI-ETiT

7 References
Text book with detailed laboratory instructions

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2092-pr</td>
<td>Power Laboratory II</td>
<td>Internship</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andreas Binder</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2090-tt</td>
<td>Laboratory Briefing</td>
<td>Tutorial</td>
<td>0</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. techn. Dr.h.c.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andreas Binder</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Module name**
Lighting Technology I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2010</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
</tr>
</tbody>
</table>

**1 Content**
Structure and functionality of the human eye, terms and unit in lighting technology, photometry, radiometric and photometric properties of materials, filters, physiology of vision, colour theory, lighting, light sources.
Measurement of luminous flux, luminous intensity, illuminance, luminance, determination of the spectral responsivity function of the human eye, colorimetry colour rendering, colour as traffic signals, measuring of optical material characteristics, LED properties

**2 Learning objectives / Learning Outcomes**
To list and connect terms, units and radiometric and photometric properties of materials in lighting technology, to describe and understand structure and functionality of the human eye and the physiology of vision, to illustrate basics of lighting, measuring methods and application.
Being able to measure base items in lighting technology, applying knowledge of lighting and enhance them with experiments. Developing a better understanding for light and color.

**3 Recommended prerequisite for participation**
MSc ETiT, MSc Wi-ETiT, MSc MEC

**4 Form of examination**
Module final exam:
• Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

**5 Grading**
Module final exam:
• Module exam (Technical examination, Oral Examination, weighting: 100%)

**6 Usability of this module**
MSc ETiT, MSc Wi-ETiT, MSc MEC

**7 References**
Script for lecture: Lighting Technology I
Excersisebook: laboratory: lighting technology I

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2010-vl</td>
<td>Lighting Technology I</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-kh-2010-pr</td>
<td>Lighting Technology I</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>PD Dr.-Ing. Peter Zsolt Bodrogi</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 Internships
<table>
<thead>
<tr>
<th><strong>Module name</strong></th>
<th>Lighting Technology II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-kh-2020</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>5 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>150 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>90 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>SoSe</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German</td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
</tr>
</tbody>
</table>

1. **Content**

2. **Learning objectives / Learning Outcomes**
   To know current developments and applications, list and connect terms, to illustrate special topics of lighting, measuring methods and application. Being able to measure base items in lighting technology, applying knowlegde of lighting and dedicated applications and further to enhance them with experiments. Developing a better understanding for light, color, perception and lighting situations.

3. **Recommended prerequisite for participation**
   Lighting Technology I

4. **Form of examination**
   Module final exam:
   - Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Technical examination, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   MSc ETiT, MSc Wi-ETiT, MSc MEC

7. **References**
   Exercisebook: laboratory: lighting technology II

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2020-vl</td>
<td>Lighting Technology II</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-kh-2020-pr</td>
<td>Lighting Technology II</td>
<td>Internship</td>
<td>2</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. Dr.-Ing. Khanh Quoc Tran</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 Internships
Module name
Microwave Measurement Technologies

Module Nr. 18-jk-2090
Credit Points 6 CP
Workload 180 h
Self study 120 h
Duration 1
Cycle offered SoSe

Language German and English
Module owner Prof. Dr.-Ing. Rolf Jakoby

1 Content
Introduction to microwave measurement technologies, high frequency components and their properties: rf power measurement, spectrum analysis, vector network analysis (s-parameter, x-parameter, calibration techniques), on-wafer measurements, load/source-pull, material characterization

2 Learning objectives / Learning Outcomes
By this module, Students will be enabled to understand the basic principles of microwave measurement technologies. They are able to use them in measurement applications. The following objectives are linked to the lecture:

• The students understand the basic features of the power measurements and the effects of a mismatch or pulsed signals and can independently carry out and interpret measurements.
• The students understand the basics of spectrum analysis and can carry out and interpret measurements independently.
• The students understand the basics of s-parameter measurements and calibration of network analyzers and can carry out and interpret measurements independently.
• Students are familiar with various methods for material characterization

3 Recommended prerequisite for participation
Recommended: Grundlagen der Nachrichtentechnik, Hochfrequenztechnik I

4 Form of examination
Module final exam:
• Module exam (Technical examination, Oral Examination, duration: 45 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc etit, MSc WI-etit, MSc iCE, MSc iST

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2090-vl</td>
<td>Microwave Measurement Technologies</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-jk-2090-ue</td>
<td>Microwave Measurement Technologies</td>
<td>Practice</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-jk-2090-pr</td>
<td>Microwave Measurement Technologies Lab</td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td>Instructor</td>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 Internships
**Module name**
Digital Signal Processing Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2030</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr.-Ing. Abdelhak Zoubir

1 **Content**
1) Introduction to MATLAB
2) Discrete-Time Signals and Systems
3) Frequency-Domain Analysis using the DFT
4) Digital FIR Filter Design
5) IIR Filter Design using Analog Prototypes
6) Nonparametric Spectrum Estimation
7) Parametric Spectrum Estimation.

2 **Learning objectives / Learning Outcomes**
The students are able to apply skills acquired in the course Digital Signal Processing. These include the design of digital FIR and IIR filters as well as non-parametric and parametric spectrum estimation. Students learn how MATLAB is used to apply theoretical concepts and to demonstrate signal processing techniques by using hands-on application examples.

3 **Recommended prerequisite for participation**
Deterministic signals and systems theory

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Written Examination, duration: 120 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Written Examination, weighting: 100%)

6 **Usability of this module**
MSc ETiT, MSc iCE

7 **References**
Lab manual

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2030-pr</td>
<td>Digital Signal Processing Lab</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>
Module name
Electromechanical Systems Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2090</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. Mario Kupnik</td>
</tr>
</tbody>
</table>

1 Content
Electromechanical sensors, drives and actuators, electronic signal processing mechanisms, systems from actuators, sensors and electronic signal processing mechanism.

2 Learning objectives / Learning Outcomes
Elaborating concrete examples of electromechanical systems, which are explained within the lecture EMS I+II.

The Analyzing of these examples is needed to explain the mode of operation and to gather characteristic values. On this students are able to explain the derivative of proposals for the solution.

The aim of the 6 laboratory experiments is to get to know the mode of operation of the electro-mechanical systems. The experimental analysis of the characteristic values leads to the derivation of proposed solutions.

3 Recommended prerequisite for participation
Bachelor ETIT

4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETIT, MSc WI-ETIT, MSc MEC

7 References
Laboratory script in Electromechanical Systems

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2090-pr</td>
<td>Electromechanical Systems Lab</td>
<td>Prof. Dr. Mario Kupnik</td>
<td>Internship</td>
<td>3</td>
</tr>
<tr>
<td>18-kn-2090-ev</td>
<td>Electromechanical Systems Lab - Introduction</td>
<td>Prof. Dr. Mario Kupnik</td>
<td>Introductory Course</td>
<td>0</td>
</tr>
</tbody>
</table>

2.2 Internships
<table>
<thead>
<tr>
<th>Module name</th>
<th>Laboratory Communication and Sensor Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-jk-2050</td>
</tr>
<tr>
<td>Credit Points</td>
<td>5 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>150 h</td>
</tr>
<tr>
<td>Self study</td>
<td>105 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
</tr>
<tr>
<td>Language</td>
<td>German and English</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
</tr>
</tbody>
</table>

1. **Content**
   - The student communications lab consist of 7 fundamental experiments out of the field of Communication Engineering:
   - Mobile Radio Channel + Diversity (SW)
   - Signal Detection and Parameter Estimation (Matlab)
   - Digital Modulation (HW)
   - Coding (SW)
   - Parasitic Effects in Passive RF Devices (SW)
   - RF FET Amplifier (HW)
   - Polarization of Light (HW)
   - Antennas:
     - Fields and Impedance (HW)

2. **Learning objectives / Learning Outcomes**
   - The students are guided to acquaint themselves with given topics. They learn to perform prepared experiments within a defined frame and minute, analyze and discuss the results. In this training the fundamentals of free scientific work are practiced.

3. **Recommended prerequisite for participation**
   - Fundamentals of:
     - Communications
     - Microwave Engineering
     - Digital Signal Processing

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Optional, weighting: 100%)

6. **Usability of this module**
   - MSc ETiT, MSc iCE, Wi-ETiT

7. **References**
   - A description of experiments is offered. It can be bought from Mr. Ziemann (S306/409) or being loaded from the WEB page.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2050-pr</td>
<td>Laboratory Communication and Sensor Systems</td>
<td>Internship</td>
<td>3</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 Internships
Module name
Laboratory Matlab/Simulink II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2070</td>
<td>4 CP</td>
<td>120 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

1 Content
The lab is split into the two parts Simulink and Control Engineering II. First the fundamentals of the simulation tool Simulink are introduced and their application to problems from different fields of application is trained. In the second part, the knowledge gained in the first part is applied to autonomously solve several control design problems as well as simulation tasks.

2 Learning objectives / Learning Outcomes
The students will be able to work with the tool MatLab/Simulink on their own and can solve tasks from the areas of control engineering and numerical simulation. The students will know the different design methods of the control system toolbox and the fundamental concepts of the simulation tool Simulink. They can practically apply the knowledge gathered in the lectures “System Dynamics and Control Systems I and II” and “Modelling and Simulation”.

3 Recommended prerequisite for participation
The lab should be attended in parallel or after the lectures “System Dynamics and Control Systems II” and “Modelling and Simulation”.

4 Form of examination
Module final exam:
• Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSC MEC

7 References
Lecture notes for the lab tutorial can be obtained at the secretariat

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2070-pr</td>
<td>Laboratory Matlab/Simulink II</td>
<td>Internship</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ulrich Konigorski
## Module name
 Multimedia Communications Lab II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2070</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
</tbody>
</table>

### 1 Content
The course deals with cutting edge development topics in the area of multimedia communication systems. Besides a general overview it provides a deep insight into a special development topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and basic scientific competences in one or more of the following topics:
- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia / e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Applications for distributed workflows

### 2 Learning objectives / Learning Outcomes
The ability to solve and evaluate problems in the area of design and development of future multimedia communication networks and applications shall be acquired. Acquired competences are:
- Design of complex communication applications and protocols
- Implementing and testing of software components for distributed systems
- Application of object-oriented analysis and design techniques
- Acquisition of project management techniques for small development teams
- Writing of software documentation and project reports
- Presentation of project advances and outcomes

### 3 Recommended prerequisite for participation
Keen interest to explore challenging topics which are cutting edge in technology and research. Further we expect:
- Solid experience in programming Java and/or C# (C/C++)
- Solid knowledge in object oriented analysis and design
- Solid knowledge in computer communication networks are recommended
- Lectures in Communication Networks I (II, III, or IV) are an additional plus

### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### 6 Usability of this module
MSc ETiT, MSc iCE, BSc/MSc iST, Wi-ETiT, BSc/MSc CS, Wi-CS,

### 7 References

2.2 Internships
Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Erich Gamma, Richard Helm, Ralph E. Johnson: "Design Patterns: Objects of Reusable Object Oriented Software" (ISBN 0-201-63361-2)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2070-pr</td>
<td>Multimedia Communications Lab II</td>
<td>Internship</td>
<td>3</td>
</tr>
</tbody>
</table>
### Module name
Laboratory Control Engineering II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2060</td>
<td>5 CP</td>
<td>150 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

1. **Content**
   - During the laboratory course the following experiments will be conducted: Coupling control of a helicopter, Non-linear control of a gyroscope, Nonlinear multivariable control of an aircraft, Servo control systems, Control of an overhead crane system, Programmable logic control of a stirring process.

2. **Learning objectives / Learning Outcomes**
   - After attending this laboratory course, a student is capable of:
     - recalling the basics of the conducted experiments,
     - organize and comprehend background information for experiments,
     - assemble experimental set-ups based on manuals,
     - judge the relevance of experimental results by comparing them with theoretically predicted outcomes,
     - present the results of the experiments

3. **Recommended prerequisite for participation**
   - System Dynamics and Control Systems II, the attendance of the additional lecture “System Dynamics and Control Systems III” is recommended.

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Written Examination, duration: 180 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Written Examination, weighting: 100%)

6. **Usability of this module**
   - MSc ETiT, MSc MEC, MSc iST, MSc Wi-ETiT, Biotechnik

7. **References**
   - Adamy: Instruction manuals for the experiments (available during the kick-off meeting)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2060-pr</td>
<td>Laboratory Control Engineering II</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
<td>Internship</td>
<td>4</td>
</tr>
</tbody>
</table>
Module name
Processor Microarchitecture

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2050</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Christian Hochberger</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (each block takes 3 * 90 minutes)</td>
</tr>
<tr>
<td>3. Execution in the micro-threaded pipeline. Interaction between cache controllers, register file, thread scheduler, integer pipeline. Data dependences between threads and its influence on execution (embarrassingly parallel vs. sequential programs). Interaction with legacy code, execution modes, OS support.</td>
</tr>
<tr>
<td>5. Microthreading in multi-core architectures. Big issues: Scalability, sufficient parallelism, trade-off between clock frequency and access latency</td>
</tr>
<tr>
<td>Labs:</td>
</tr>
<tr>
<td>1. Set up the utgrlib VHDL sources in the home directory. Set up the utbinutils in the home directory. Compilation of introductory examples.</td>
</tr>
<tr>
<td>10.-15. Integration of the block in UTLEON3, execution of micro-threaded programs, evaluation of performance analysis (% performance gain over the original block, % decreased resource requirements).</td>
</tr>
</tbody>
</table>

2 Learning objectives / Learning Outcomes
After completion of the module, students will be able to design a customized microarchitecture of a modern RISC processor and analyze its performance. The course will be taught using a VHDL implementation of an existing micro-threaded processor UTLEON3 in an FPGA, nevertheless the knowledge gained in the lecture will be applicable to other HDLs, different processor architectures and other implementation technologies.

3 Recommended prerequisite for participation
Hands-on experience with at least one of Verilog or VHDL is expected. Basic understanding of FPGA technology and thorough knowledge of digital circuit design and computer architecture. Several tools used throughout the labs might require additional programming languages and tools (Perl, C, bash). This knowledge can be obtained during the labs.

4 Form of examination
Module final exam:
- Module exam (Technical examination, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Technical examination, Oral Examination, weighting: 100%)

6 Usability of this module
MSc ETiT, MSc iCE, MSc iST

7 References
A script is available as a published book and English slides can be obtained through moodle.

| Courses |
|-----------------|-----------------|
| **Course Nr.** | **Course name** |
| 18-hb-2050-vl  | Processor Microarchitecture |
| **Instructor** | **Type** | **SWS** |
| Ph.D. Martin Danek | Lecture | 2 |
| **Course Nr.** | **Course name** |
| 18-hb-2050-pr  | Processor Microarchitecture |
| **Instructor** | **Type** | **SWS** |
| Ph.D. Martin Danek | Internship | 2 |
**Module name**
Simulation of Electrical Power Networks

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2100</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
</tr>
</tbody>
</table>

1 **Content**
Modeling, simulating and planning electrical power networks with a wide range of nominal voltages under consideration of electrical equipment (overhead lines, cables, transformers, conventional power plants, renewable energy resources und reactive power compensation systems)

2 **Learning objectives / Learning Outcomes**
The learning targets are the following:
- Modeling various electrical power systems using the appropriate techniques.
- Choice of static and dynamic simulation techniques after analysing the concrete simulation processes.
- Understanding the behaviour of various equipment in the electric power system, especially renewable energy resources. Interpretation of results based on the fundamental questions of modeling and simulating electrical power systems.

3 **Recommended prerequisite for participation**
Basics of electrical power systems

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6 **Usability of this module**
MSc ETiT, MSc WI-ET, MSc CE

7 **References**
Script, Presentation Slides, Description of tutorial and basic network data

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2100-pr</td>
<td>Simulation of Electrical Power Networks</td>
<td>Internship</td>
<td>2</td>
</tr>
</tbody>
</table>
2.3 Seminars

<table>
<thead>
<tr>
<th>Module name</th>
<th>Advanced Topics in Statistical Signal Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-zo-2040</td>
</tr>
<tr>
<td>Credit Points</td>
<td>8 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>240 h</td>
</tr>
<tr>
<td>Self study</td>
<td>180 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
</tr>
</tbody>
</table>

1 Content
This course extends the signal processing fundamentals taught in DSP towards advanced topics that are the subject of current research. It is aimed at those with an interest in signal processing and a desire to extend their knowledge of signal processing theory in preparation for future project work (e.g. Diplomarbeit) and their working careers. This course consists of a series of five lectures followed by a supervised research seminar during two months approximately. The final evaluation includes students seminar presentations and a final exam.
The main topics of the Seminar are:
- Estimation Theory
- Detection Theory
- Robust Estimation Theory
- Seminar projects: e.g. Microphone array beamforming, Geolocation and Tracking, Radar Imaging, Ultrasound Imaging, Acoustic source localization, Number of sources detection.

2 Learning objectives / Learning Outcomes
Students obtain advanced knowledge in signal processing based on the fundamentals taught in DSP and ETIT 4. They will study advanced topics in statistical signal processing that are subject to current research. The acquired skills will be useful for their future research projects and professional careers.

3 Recommended prerequisite for participation
DSP, general interest in signal processing is desirable.

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETIT, BSc/MSc iST, MSc iCE, Wi-ETIT

7 References

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2040-se</td>
<td>Advanced Topics in Statistical Signal Processing</td>
<td>Seminar</td>
<td>4</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
Application, Simulation and Control of Power Electronic Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2030</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr.-Ing. Gerd Griepentrog

---

### Content
In an introductory meeting topics according to power electronics and control of drives are given to the students. During the seminar problems can be treated concerning the following topics:

- Simulation of power electronic systems plus analysis and evaluation of the models
- Implementing and startup of power electronic systems, test stand development plus measurement of characteristic parameters
- Modeling and simulation in the field of control of electrical drives
- Implementing and startup of controlled drive systems
- Suggested topics from the students are welcome

The students are working autonomous on the chosen problem. The results are documented in a written report and at the end of the module, a presentation about the problem must be held.

### Learning objectives / Learning Outcomes
The Competences are:

- Autonomous familiarization with a given problem
- Selection and evaluation of appropriate development tools
- Familiarization with the used development tools
- Practical experience in power electronics and control of drives
- Logical presentation of the results in a report
- Presentation skills

### Recommended prerequisite for participation
Lecture „Leistungselektronik 1“ or „Einführung Energietechnik“ and ggf. „Regelungstechnik I“ or similar

### Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc MEC

### References
Definition of project task

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-2030-se</td>
<td>Application, Simulation and Control of Power Electronic Systems</td>
<td>Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Gerd Griepentrog

---

2.3 Seminars
Module name
Calculation of Transients in electrical Power Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2060</td>
<td>6 CP</td>
<td>180 h</td>
<td>150 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
</tr>
</tbody>
</table>

1 Content
In two introductory lectures, basics of the modelling and simulation of electric power systems for transient studies are presented. Then, the respective simulation software is introduced and used by the participants in exercises.

The participants then work on a given task in the field of modelling and simulation of transients in electric power systems.

2 Learning objectives / Learning Outcomes
The goals of education are
- Working on a given technical question out of the area of network planning and network calculation
- Supervised and individual Elaboration of a simulation software
- Individual elaboration of the given technical task
- Logical presentation of results in a report
- Presentation of the final report (10 mins)

3 Recommended prerequisite for participation
Contents of lectures "Energieversorgung" I and II

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc EPE, MSc Wi-ETiT

7 References
Lecture Notes, software manual, exercise task, definition of project task

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2060-se</td>
<td>Calculation of Transients in electrical Power Systems</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson
**Module name**
Computational Modeling for the IGEM Competition

**Module Nr.**  
18-kp-2100

**Credit Points**  
4 CP

**Workload**  
120 h

**Self study**  
90 h

**Duration**  
1

**Cycle offered**  
WiSe/SoSe

**Language**  
English

**Module owner**  
Prof. Dr. techn. Heinz Köppl

---

1 **Content**
The International Genetically Engineered Machine (IGEM) competition is a yearly international student competition in the domain of synthetic biology, initiated and hosted by the Massachusetts Institute of Technology (MIT), USA since 2004. In the past years teams from TU Darmstadt participated and were very successfully in the competition. This seminar provides training for students and prospective IGEM team members in the domain of computational modeling of biomolecular circuits. The seminar aims at computationally inclined students from all background, but in particular from electrical engineering, computer science, physics and mathematics. Seminar participants that are interested to become IGEM team members could later team up with biologists and biochemists for the 2017 IGEM project of TU Darmstadt and be responsible for the computational modeling part of the project.
The seminar will cover basic modeling approaches but will focus on discussing and presenting recent high-impact synthetic biology research results and past IGEM projects in the domain of computational modeling.

2 **Learning objectives / Learning Outcomes**
Students that successfully passed that seminar should be able to perform practical modeling of biomolecular circuits that are based on transcriptional and translational control mechanism of gene expression as used in synthetic biology. This relies on the understanding of the following topics:
- Differential equation models of biomolecular processes
- Markov chain models of biomolecular processes
- Use of computational tools for the composition of genetic parts into circuits
- Calibration methods of computational models from experimental measurement
- Use of bioinformatics and database tools to select well-characterized genetic parts

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Study archievments, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study archievments, Optional, weighting: 100 %)

6 **Usability of this module**
BSc etit, MSc etit

7 **References**

---

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kp-2100-se</td>
<td>Computational Modeling for the IGEM Competition</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr. techn. Heinz Köppl
Module name
Future Electrical Power Supply

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2020</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Jutta Hanson</td>
</tr>
</tbody>
</table>

1 Content
The goal of this seminar is to acquire a comprehensive knowledge of a promising topic for the power system of the future.
Two topics from the field of electrical power supply will be offered. These topics are assigned to groups. The groups consist of four participants. Each group is supervised by an academic staff from the department E5 who has knowledge of the specified topic. During the seminar, dates for appointments will be regularly offered by the tutor for the participants. During these meetings technical issues will be discussed. At the end of the seminar each group is required to write a final report and do a presentation (duration 20 min. plus questions) about its topic. Both the final report and presentation can be done in English or in German.

2 Learning objectives / Learning Outcomes
The education goals are:

- Acquisition of comprehensive knowledge about a promising topic in the electrical power system
- Individual working on technical subjects
- Elaboration of a written report
- Logical presentation of the results in a presentation

3 Recommended prerequisite for participation
Successful participation in “Elektrische Energieversorgung I” or lectures with similar contents at other universities. Good German language skills are desirable, but not required.

4 Form of examination
Module final exam:

- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:

- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc EPE

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hs-2020-se</td>
<td>Future Electrical Power Supply</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jutta Hanson

2.3 Seminars 255
### Module name
European Microwave School

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2080</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>Every 2. Sem.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
</tr>
</tbody>
</table>

1. **Content**
   - Introduction to radar technologies and techniques
   - Radar RF fronts
   - Radarsignal processing
   - Application of radar systems in automobiles, in industrial environments
   - Radar systems for space applications

2. **Learning objectives / Learning Outcomes**
The programme is designed to lay the foundations, both mathematically as well as conceptually, for microwave measurements. It will enable a fundamental understanding of high frequency measurement techniques, and will prepare students to become intelligent users of commercial microwave measurement devices.

3. **Recommended prerequisite for participation**
Attending the seminar in Nürnberg (!) is mandatory.
Fundamentals of communication theory and techniques, Microwave Engineering I

4. **Form of examination**
Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
BSc ETiT

7. **References**
A handout will be provided during the seminar.
Homepage: http://www.eumweek.com/students/studentschool.html

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2080-se</td>
<td>European Microwave School</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr.-Ing. Holger Maune</td>
<td></td>
</tr>
</tbody>
</table>
**Module name**
International Summer School 'Microwaves and Lightwaves'

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2050</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr.-Ing. Franko Küppers

1. **Content**
This lecture covers the fundamentals and the latest developments of microwave electronics, THz technology, and optical communication systems with particular focus on the physical concepts involved.

2. **Learning objectives / Learning Outcomes**
   Students understand
   - the background of microwave engineering, THz engineering, and optical communications and
   - of related electronics, and
   - the influence of the relevant properties of materials and of waveguides on signal processing.

   They gain insight into the latest developments in these fields.

3. **Recommended prerequisite for participation**

4. **Form of examination**
Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100%)

6. **Usability of this module**
BSc ETiT, MSc ETiT

7. **References**
A script (English) will be distributed and English slides can be downloaded.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2050-se</td>
<td>International Summer School “Microwaves and Lightwaves”</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Franko Küppers
<table>
<thead>
<tr>
<th>Module name</th>
<th>Design of Electrical Machines and Actuators with Numerical Field Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-bi-2110</td>
</tr>
<tr>
<td>Credit Points</td>
<td>5 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>150 h</td>
</tr>
<tr>
<td>Self study</td>
<td>120 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

1 **Content**
Introduction to Finite Element Method (FEM), Basic examples of electromagnetic devices designed in 2D with FEM, 2D electromagnetic Design of transformers, AC machines, permanent magnet devices; eddy current applications such as squirrel-cage machines (Example: Wind generator); Cooling systems and thermal design: Calculation of temperature distribution within power devices.

2 **Learning objectives / Learning Outcomes**
A good knowledge in applying FEMAG and ANSYS software package to basic field problems is gained.

3 **Recommended prerequisite for participation**
Strongly recommended is the attendance of lecture and active co-operation in the tutorial “Energy Converters - CAD and System Dynamics”

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
MSc EPE, MSc ETiT, MSc MEC.

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2110-se</td>
<td>Design of Electrical Machines and Actuators with Numerical Field Calculation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

2.3 Seminars
## Module name
Optical Communications 3 – Seminar WDM Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2080</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Franko Küppers</td>
</tr>
</tbody>
</table>

### Content
- Building blocks and design of a high-bit rate transmission system
- Experimental set-up
- Characterizing components and signals by taking measurements
- Simulation and optimization of the system
- Presentation

### Learning objectives / Learning Outcomes
Students are able to design, to simulate, to optimize, to build, and to characterize an optical transmission system.

### Recommended prerequisite for participation
Optical Communications 2 – Systems

### Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100%)

### Usability of this module
MSc ETiT, MSc iCE

### References
Seminar slides, script, laboratory.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2080-se</td>
<td>Optical Communications 3 – Seminar WDM Lab</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Franko Küppers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module name</td>
<td>Planning and Application of Electrical Drives (Drives for Electric Vehicles)</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-bi-2120</td>
<td></td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>5 CP</td>
<td></td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>150 h</td>
<td></td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>120 h</td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>SoSe</td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German</td>
<td></td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
<td></td>
</tr>
</tbody>
</table>

1. **Content**
   Mono- and hybrid drive concepts, motor technology, DC and AC machines, drive systems, car dynamic, energy storage; Seminary work: simulation of car with electric drive train, presentation of seminary work

2. **Learning objectives / Learning Outcomes**
   Knowledge on design procedures for electric modulation systems for electric and hybrid cars

3. **Recommended prerequisite for participation**
   Bachelor in Electrical Engineering or Mechatronics, “Electrical Drives and Machines” and "Power electronics" recommended

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   MSc ETiT, MSc MEC, MSc EPE, MSc WI-ETiT

7. **References**
   Textbook; Binder, A.: Electric machines and drives I, Darmstadt Univ. of Technology
   Mitschke, M.: Dynamik der Kraftfahrzeuge, Springer Verlag Berlin

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2120-se</td>
<td>Planning and application of electrical drives (Drives for electric vehicles)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Harald Neudorfer</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

2.3 Seminars 260
Module name
Key skills with a focus on language

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2110</td>
<td>6 CP</td>
<td>180 h</td>
<td>120 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Ulrich Konigorski

1 Content
- This seminar teaches the students the relevant competences which will be expected within the mechatronics program to handle oral and written communication successfully. Throughout this the seminar scientific texts will be written and analyzed such that they can be beneficial for the student’s own studies. Key aspects will be: structuring, techniques for oral and written communication, designing handouts, statements, preparing reports, essays and presentations.
- The seminar „key skills“ which will be held in 4 day workshop will teach students how to cope with everyday life in Germany and will provide assistance in order to make the stay in Germany as successfully as possible. Support for the students will be provided in order to structure them, to find answers why Germans are how they are, which values are important to Germans and how different perceptions can lead to misunderstandings. Possible problems will be addressed in the group and solutions will be worked out. The topics of the workshops are:
  - Living and studying in Germany (2 day workshop)
  - Successful teamwork (1 day workshop)
  - Learning effectively and time management (1 day workshop)
  - Expectations within the university (1 day workshop)

2 Learning objectives / Learning Outcomes
After successfully attending this module the students will be capable of
- structuring their written and oral communication,
- using techniques for lecturing and presenting,
- designing handouts,
- framing statements and reports scientifically,
- understanding and analyzing Germany’s cultural standards and habits,
- coping with misunderstandings appearing in private and university contexts using strategies of de-escalation,
- developing understanding for expectations within the university context and act accordingly,
- defining strategies for successful teamwork and act accordingly,
- employing methods of effective learning,
- carrying out effective time management,
- identifying their own potential and to cope with special challenges.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100%)

6 Usability of this module
MSc MEC, MSc ETiT, MSc MPE

7 References
Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2110-se</td>
<td>Speaking and Writing in Academic Contexts</td>
<td>Seminar</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>M. A. Monika Thom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Nr.</td>
<td>Course name</td>
<td>Type</td>
<td>SWS</td>
</tr>
<tr>
<td>18-ko-2111-se</td>
<td>Seminar Key Skills</td>
<td>Seminar</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Module name**  
Seminar Integrated Electronic Systems Design A

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2160</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

**1 Content**  
Research oriented Formulation of a Topic within the area of Microelectronics System Design; Creation of a written Documentation and Presentation; Team Work

**2 Learning objectives / Learning Outcomes**  
A student is, after successful completion of this module, able to 1. gain a deep understanding of the chosen research subject in the field of integrated electronic systems, 2. write an essay on the chosen subject in a comprehensive form and present the outcome to an audience

**3 Recommended prerequisite for participation**  

**4 Form of examination**  
Module final exam:  
• Module exam (Study achievements, Oral Examination, duration: 45 min, standard grading system)

**5 Grading**  
Module final exam:  
• Module exam (Study achievements, Oral Examination, weighting: 100 %)

**6 Usability of this module**  
MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC

**7 References**  
Topic-oriented Materials will be provided

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2160-se</td>
<td>Seminar Integrated Electronic Systems Design A</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor  
Prof. Dr.-Ing. Klaus Hofmann

2.3 Seminars  
263
Module name
Multimedia Communications Seminar I

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2300</td>
<td>4 CP</td>
<td>120 h</td>
<td>75 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Ralf Steinmetz

1 **Content**
The seminar investigates current and upcoming topics in multimedia communication systems, which are expected to be of utmost importance for the future evolution of the Internet and information technology in goal. The goal is to learn more about multimedia communication systems by studying, summarizing, and presenting top quality papers from recent high quality networking research journals, magazines, or conferences. The selection of topics corresponds to the research area of participating researchers.

Possible topics are:
- Knowledge & Educational Technologies
- Self organizing Systems & Overlay Communication
- Mobile Systems & Sensor Networking
- Service-oriented Computing
- Multimedia Technologies & Serious Games

2 **Learning objectives / Learning Outcomes**
The students are actively studying cutting edge scientific articles, standards, and books about multimedia communication systems and applications, which are expected to be of utmost important for the future of the Internet.

Students acquire competences in the following areas:
- Searching and reviewing of relevant scientific literature
- Analysis and evaluation of complex technical and scientific information
- Writing of technical and scientific summaries and short papers
- Presentation of complex technical and scientific information

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6 **Usability of this module**
CS, WiCS, ETiT, Wi-ETiT, BSc/MSc iST

7 **References**
Depending on specific topic (selected articles of journals, magazines, and conferences).

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2300-se</td>
<td>Multimedia Communications Seminar I</td>
<td>Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ralf Steinmetz

2.3 Seminars
### Module name
Multimedia Communications Seminar II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2090</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
</tr>
</tbody>
</table>

1 **Content**
This seminar deals with current and upcoming trends relevant to the future development of multimedia communication systems. The educational objective of this seminar is to gain knowledge about future research trends in different areas. To this aim, an extensive literature research will be performed, as well as the writing-up of a report and the presentation of selected, high-quality research topics from current leading magazines, newspapers and conferences in the web technologies research area. Some potential topics are:
- Knowledge & Educational Technologies
- Self organizing Systems & Overlay Communication
- Mobile Systems & Sensor Networking
- Service-oriented Computing
- Multimedia Technologies & Serious Games

2 **Learning objectives / Learning Outcomes**
Students shall acquire profound knowledge from current scientific publications, standards and literature on multimedia communication systems and applications which will build the future Internet. In so doing, the students will develop the following competencies:
- Search for and review relevant scientific literature.
- Analyse and evaluate complex technical and scientific information.
- Write technical and scientific abstracts and summary reports.
- Present technical and scientific information.

3 **Recommended prerequisite for participation**
Solid knowledge in computer communication networks. Lectures in Communication Networks I and II are recommended.

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6 **Usability of this module**
CS, Wi-CS, ETiT, Wi-ETiT, MSc CS, MSc ETiT, MSc iST

7 **References**
Depending on specific topic (selected articles of journals, magazines, and conferences).

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2090-se</td>
<td>Multimedia Communications Seminar II</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Ralf Steinmetz</td>
<td></td>
</tr>
</tbody>
</table>
Module name
Accelerator Physics and Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2070</td>
<td>6 CP</td>
<td>180 h</td>
<td>165 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Herbert De Gersem

1 **Content**
Learn and understand the theoretical contexts in the field of accelerator physics; application of the theoretical background to practical examples related to current projects in the field.

2 **Learning objectives / Learning Outcomes**
The seminar addresses various topics relevant to accelerator physics and technology which in detail depend on the guest lecturers. So, insight into the current developments as well as into the different projects in the area is given. Moreover, the focus is put on the practical challenges arising during the design, construction and commissioning phase of the particular accelerator projects.

3 **Recommended prerequisite for participation**
Basic knowledge in the field of accelerator physics and technology is useful, though not mandatory.

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 **Usability of this module**
MSc ETiT

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2070-se</td>
<td>Accelerator Physics and Technology</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td>Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>
### Module name
Seminar Software System Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2080</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. rer. nat. Andreas Schürr</td>
</tr>
</tbody>
</table>

1. **Content**
   In this course, the students produce scientific reports from changing subject areas. Each student has to explore a subject related to IT system development and produce a written report as well as a final talk with a presentation. A list of the subjects of the current semester is available at www.es.tu-darmstadt.de/lehre/sst.

2. **Learning objectives / Learning Outcomes**
   After a successful participation, the students will be able to explore an unknown topic under scientific aspects. The students learn to support the exploration by a literature research and to analyze the subject critically. They achieve the skills to present a definite subject in a written report as well as in an oral presentation.

3. **Recommended prerequisite for participation**
   Basic knowledge in software engineering and programming languages

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   BSc iST, BSc Informatik, MSc ETiT

7. **References**
   www.es.tu-darmstadt.de/lehre/sst

---

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2080-se</td>
<td>Seminar Software System Technology</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr. rer. nat. Andreas Schürr

---

2.3 Seminars 267
### Module name
Seminar on Special Topics of Optical Communications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2030</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr.-Ing. Franko Küppers

---

1. **Content**
   - Building blocks and design of a high-bit rate transmission system
   - Experimental set-up
   - Characterizing components and signals by taking measurements
   - Simulation and optimization of the system
   - Presentation

2. **Learning objectives / Learning Outcomes**
   - Students are able to design, to simulate, to optimize, to build, and to characterize an optical transmission system.

3. **Recommended prerequisite for participation**
   - Systems of Optical Communications

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   - MSc ETIT, MSc iCE

7. **References**
   - Seminar slides, laboratory.

---

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ku-2030-se</td>
<td>Seminar on Special Topics of Optical Communications</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr.-Ing. Franko Küppers

**Type**
Seminar

**SWS**
3
## Module name
Seminar: Integrated Electronic Systems Design B

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2161</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

### Content
Research oriented Formulation of a Topic within the area of Microelectronics System Design; Creation of a written Documentation and Presentation; Team Work

### Learning objectives / Learning Outcomes
A student is, after successful completion of this module, able to 1. gain a deep understanding of the chosen research subject in the field of integrated electronic systems, 2. write an essay on the chosen subject in a comprehensive form and present the outcome to an audience

### Recommended prerequisite for participation

### Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 45 min, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

### Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC

### References
Topic-oriented Materials will be provided

### Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2161-se</td>
<td>Seminar: Integrated Electronic Systems Design B</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
<td>Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

---

2.3 Seminars 269
**Module name**
Signal Detection and Parameter Estimation

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2050</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

**Language**
English

**Module owner**
Prof. Dr.-Ing. Abdelhak Zoubir

**Content**
Signal detection and parameter estimation are fundamental signal processing tasks. In fact, they appear in many common engineering operations under a variety of names. In this course, the theory behind detection and estimation will be presented, allowing a better understanding of how (and why) to design “good” detection and estimation schemes.

These lectures will cover:
- Fundamentals
- Detection Theory Hypothesis Testing
- Bayesian Tests
- Ideal Observer Tests
- Neyman-Pearson Tests
- Receiver Operating Characteristics
- Uniformly Most Powerful Tests
- The Matched Filter Estimation Theory
- Types of Estimators
- Maximum Likelihood Estimators
- Sufficiency and the Fisher-Neyman/Factorisation Criterion
- Unbiasedness and Minimum variance
- Fisher Information and the CRB
- Asymptotic properties of the MLE

**Learning objectives / Learning Outcomes**
Students gain deeper knowledge in signal processing based on the fundamentals taught in DSP and EtiT 4. They will study advanced topics of statistical signal processing in the area of detection and estimation. In a sequence of 4 lectures, the basics and important concepts of detection and estimation theory will be taught. These will be studied in dept by implementation of the methods in MATLAB for practical examples. In sequel, students will perform an independent literature research, i.e. choosing an original work in detection and estimation theory which they will illustrate in a final presentation. This will support the students with the ability to work themselves into a topic based on literature research and to adequately present their knowledge. This is especially expected in the scope of the students’ future research projects or in their professional career.

**Recommended prerequisite for participation**
DSP, general interest in signal processing

**Form of examination**
Module final exam:
- Module exam (Study achievement, Optional, standard grading system)

**Grading**
Module final exam:
- Module exam (Study achievement, Optional, weighting: 100 %)

**Usability of this module**
MSc ETiT, MSc iST, MSc iCE, Wi-ETiT

**References**
• Lecture slides

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-zo-2050-se</td>
<td>Signal Detection and Parameter Estimation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Abdelhak Zoubir</td>
<td>Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
1 **Content**
Intensive arguing with current research topics in microsystem technology. The compilation of self gathered information and a scientific report are evaluated thereby and consulted as test achievement.

2 **Learning objectives / Learning Outcomes**
To explain current specialized topics in the area of the micro system technology. To work out a scientific specialized topic independently, and to give a lecture on it. To write a scientific report about this topic. Getting to know the institute's own clean room laboratory for MEMS fabrication. Autonomus fabrication of micro structures.

3 **Recommended prerequisite for participation**
Microsystem Technology

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc MEC, MSc WI-ETiT

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2050-se</td>
<td>Advanced seminar Microsystem Technology</td>
<td>Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>
2.4 Introductory Seminar Courses

<table>
<thead>
<tr>
<th>Module name</th>
<th>Selected Chapters from Measuring and Sensor Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-kn-2140</td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
</tr>
<tr>
<td>Self study</td>
<td>90 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr. Mario Kupnik</td>
</tr>
</tbody>
</table>

1. Content
The module promotes the interlinking with current research contents and transferring from theoretical knowledge that already gained into practical applications of measuring and sensor technique. The module treats modeling methods and tools such as statistic design of experiments, analysis methods for error propagation and applications of sensors and sensor systems in current research questions in the form of a few similar to lecture introduction events and as an independent work of the students. In comparison to final works (thesis) only single aspects of a subject are looked deeply within the scope of the module.

2. Learning objectives / Learning Outcomes
The students learn to apply existing knowledge from the measuring and sensor technique for the modelling or Simulation of a system, to work up the structured results and to present.

3. Recommended prerequisite for participation
Measuring Technique, Sensor Technique, Sensor Signal Processing

4. Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5. Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100%)

6. Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc MEC

7. References
Slide set of lecture

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2140-ps</td>
<td>Selected Chapters from Measuring and Sensor Technique</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr. Mario Kupnik</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 Introductory Seminar Courses
2.5 Project Seminars

<table>
<thead>
<tr>
<th>Module name</th>
<th>Science in Practice I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-dg-2130</td>
</tr>
<tr>
<td>Credit Points</td>
<td>8 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>240 h</td>
</tr>
<tr>
<td>Self study</td>
<td>180 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German and English</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

1. **Content**
   - Acquiring basic scientific skills based on concrete examples from the literature.

2. **Learning objectives / Learning Outcomes**
   - The students possess basic scientific skills. They are able to discover important literature for a given topic and to judge critically the corresponding content. They are familiar with numerical techniques, especially convergence studies relevant for praxis. The students are capable of analyzing errors within simulations and of judging accuracy requirements, e.g., with respect to errors in input data.

3. **Recommended prerequisite for participation**
   - Good understanding of electromagnetic fields, knowledge about numerical simulation methods.

4. **Form of examination**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)

5. **Grading**
   - Module final exam:
     - Module exam (Study achievements, Oral Examination, weighting: 100%)

6. **Usability of this module**
   - MSc ETiT

7. **References**
   - Material related to the topic is provided.

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2130-pj</td>
<td>Science in Practice I</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
### Module name
Science in Practice II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2140</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German and English</td>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working on different scientific topics based on techniques acquired in Science in Practice I.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2 Learning objectives / Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students are capable of successfully working on new scientific topics from the numerical field simulation in a reasonable time. They are able to understand new methods, to implement them if necessary and to carry out simulations. Thereby methodologies discussed in Science in Practice I, especially concerning the solution of systems of equations, as well as convergence and error analysis are employed. They know how to document the results by means of a report and how to present them.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 Recommended prerequisite for participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good understanding of electromagnetic fields, knowledge about numerical simulation methods.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4 Form of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module final exam:</td>
</tr>
<tr>
<td>- Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module final exam:</td>
</tr>
<tr>
<td>- Module exam (Study achievements, Oral Examination, weighting: 100 %)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6 Usability of this module</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc ETiT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7 References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material related to the topic is provided.</td>
</tr>
</tbody>
</table>

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-dg-2140-pj</td>
<td>Science in Practice II</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Herbert De Gersem</td>
</tr>
</tbody>
</table>
Module name
Advanced Topics in Micro- and Nano Electronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2030</td>
<td>4 CP</td>
<td>120 h</td>
<td>90 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr. rer. nat. Udo Eugen Schwalke

1. **Content**
   - Choice of an up-to-date theme complex or issue of the field of semiconductor technology
   - Investigation and conditioning of the extracted material
   - Orientation in a specific project using simulation techniques
   - Compilation of a concept and presentation
   - Preparation of a presentation in conference style
   - Presentation of recitation with subsequent discussion in plenum

2. **Learning objectives / Learning Outcomes**
   - gain practice in searching relevant scientific informations in technical publications, conference articles, etc.
   - learn, how and where to acquire information about specific scientific topics elaborate one specific topic complex into a consistent presentation
   - presentation of the theme with presentation slides, handouts and subsequent critical discussion with the audience
   - ability to condition results of research for presentations for international conferences and company-internal talks and to present them in a stilistically correct manner

3. **Recommended prerequisite for participation**
   - Electrical Measuring Techniques
   - Laboratory Measuring Techniques
   - Microelectronic devices - the basics
   - Electrical Engineering and Information Technology 1
   - Electrical Engineering and Information Technology 2
   - Laboratory ETiT 1
   - Laboratory ETiT 2
   - Mathematics 1
   - Mathematics 2
   - Introductory Physics

4. **Form of examination**
Module final exam:  
   - Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:  
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
MSc ETiT

7. **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sw-2030-pj</td>
<td>Advanced Topics in Micro- and Nano Electronics</td>
<td>Project Seminar</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Udo Eugen Schwalke
<table>
<thead>
<tr>
<th>Module name</th>
<th>Product Development Methodology III</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2101</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr. Mario Kupnik</td>
</tr>
</tbody>
</table>

1. **Content**  
Practical experiences by using methodical procedures in the development of technical products. In addition teamwork, verbal and written representation of results and the organisation of development. Work in a project team and organize the development process independently.

2. **Learning objectives / Learning Outcomes**  
Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as bills of materials, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect.

3. **Recommended prerequisite for participation**  
Product Development Methodology I

4. **Form of examination**  
Module final exam:  
- Module exam (Study achievements, Optional, standard grading system)

5. **Grading**  
Module final exam:  
- Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**  
MSc ETiT, MSc MEC, MSc WI-ETiT

7. **References**  
Script: Development Methodology (PEM)

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kn-2101-pj</td>
<td>Product Development Methodology III</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr. Mario Kupnik

---

2.5 Project Seminars  
277
## Module name

Product Development Methodology IV

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2101</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
</tr>
</tbody>
</table>

### Content

Practical experiences by using methodical procedures in the development of technical products. In addition teamwork, verbal and written representation of results and the organization of development. Work in a project team and organize the development process independently.

### Learning objectives / Learning Outcomes

Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as part lists, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect.

### Recommended prerequisite for participation

Product Development Methodology I

### Form of examination

Module final exam:

- Module exam (Study achievements, Optional, standard grading system)

### Grading

Module final exam:

- Module exam (Study achievements, Optional, weighting: 100%)

### Usability of this module

MSc ETiT, MSc MEC

### References

Script: Development Methodology (PEM)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2101-pj</td>
<td>Product Development Methodology IV</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

### Instructor

Prof. Dr.-Ing. Helmut Schlaak
Module name
Project Seminar Advanced µWave Components & Antennas

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2060</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Rolf Jakoby

1 Content
Groups of 2-3 students per project. Students work out a well defined fundamental or actual research-related problem. The projects will be actualized in each cycle being offered and introduced at the beginning. Each group will be supervised individually. The projects comprise modern antennas for multitudinous applications, electronically-steerable antennas, RFIDs, RF sensors, adaptive tunable components such as matching networks, filter, passive mixer and modulator for next-generation mobile terminals and sensor systems.

2 Learning objectives / Learning Outcomes
Research-oriented Project Seminar in groups of 2-3 students per project with individual supervision. Students will learn
- how to solve scientific hardware-oriented problems
- working out concepts
- how to design, realize and characterize RF devices
- how to use commercial software and characterization tools
- to evaluate and discuss their work in the context of the state-of-art in this field
- to write a brief scientific report about their work
- to present and discuss their results at the end of the Project Seminar

3 Recommended prerequisite for participation
Fundamentals of Microwave Engineering I and Antennas and Adaptive Beamforming

4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc iCE, Wi-ETiT

7 References
Publications will be handed out to them. Software and characterization tools as well as tools to realize RF devices are available.

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-jk-2060-pj</td>
<td>Project Seminar Advanced µWave Components &amp; Antennas</td>
<td>Prof. Dr.-Ing. Rolf Jakoby</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

2.5 Project Seminars
Module name
Project Seminar Wireless Communications

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2040</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
English

Module owner
Prof. Dr.-Ing. Anja Klein

1 Content
Solving special Problems concerning mobile communications (problems concerning signal transmission and processing as well as problems concerning the network are possible, topics will be defined out of the current research topics of the lab),
working on the project in teams together (2-3 students)
organizing and structuring of a project
dealing with scientific publications, reading up the theoretical background of the task
practical work on a complex task
scientific presentation of the results (report/presentation)
defending the work in an oral discussion including an audience

2 Learning objectives / Learning Outcomes
After completion of the course, students possess
• the ability to classify and analyze special problems concerning mobile communications,
• the knowledge to plan and organize projects with temporal limitation,
• the capability to setup and test methodologies for analysis and simulation- environments,
• skills to evaluate and present achieved results and achieved conclusions.

3 Recommended prerequisite for participation
Previous knowledge in digital communications, signal processing, mobile radio

4 Form of examination
Module final exam:
• Module exam (Study achievements, Oral Examination, duration: 20 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc CE, MSc iCE, MSc iST, MSc MEC

7 References
Lecture documentation will be provided and specific literature will be announced during the course.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kl-2040-pj</td>
<td>Project Seminar Wireless Communications</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Anja Klein

2.5 Project Seminars
### Module name
Projekt Seminar Advanced Algorithms for Smart Antenna Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2040</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
</tr>
</tbody>
</table>

1. **Content**
   This project-seminar course introduces the basics of the theory and applications of smart antennas including space-time and multiple-input multiple-output communications, direction-of-arrival estimation and source localization in antenna arrays, and adaptive multiantenna techniques for interference suppression, adaptive transmit and receive beamforming, concensus and defusion algorithms for wireless sensor networks.

2. **Learning objectives / Learning Outcomes**
   Students will understand theory, algorithms and applications of smart antennas.

3. **Recommended prerequisite for participation**
   Knowledge of basic communication theory

4. **Form of examination**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, duration: 40 min, standard grading system)

5. **Grading**
   Module final exam:
   - Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
   MSc ETiT, MSc Wi-ETiT, MSc iCE

7. **References**

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2040-pj</td>
<td>Projekt Seminar Advanced Algorithms for Smart Antenna Systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
# Module name
Projekt Seminar Procedures for Massive MIMO and 5G

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2050</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
</tr>
</tbody>
</table>

## Content
This project-seminar introduces the basics concepts of the signal processing algorithms and cross-layer procedures for extremely large so-called Massive MIMO systems and mobile communication networks of the 5th generation (5G).

In Massive MIMO systems the number of base transmit and receive antennas at the base station are scaled up, as compared to usual MIMO systems, by several orders of magnitude. In this seminar we investigate advanced signal processing algorithms which allow to exploit the advantages of Massive MIMO in an optimum way (which are high data rate, high reliability, favorable propagation characteristics), to cope with the enormous date volume (linear signal processing) and to master the challenges (pilot contamination, low-cost hardware). Massive MIMO is an integral part of the emerging 5G mobile communication networks. In the course of the seminar the fundamental concepts and challenges of 5G networks will be discussed. It includes concepts as Small Cells, Cloud RAN, Network Virtualization, Network slicing, Machine-to-Machine communication, Millimeter Wave Transmission, Flexible Waveforms, etc.

## Learning objectives / Learning Outcomes
Students will learn the fundamental concepts, procedures, theories, algorithms and applications of Massive MIMO systems and 5G mobile communication networks by the latest scientific publications.

## Recommended prerequisite for participation

## Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 40 min, standard grading system)

## Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

## Usability of this module
MSc ETiT, MSc Wi-ETiT, MSc iCE

## References
- [http://www.massivemimo.eu/](http://www.massivemimo.eu/)

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-pe-2050-pj</td>
<td>Projekt Seminar Procedures for Massive MIMO and 5G</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Marius Pesavento</td>
<td></td>
</tr>
</tbody>
</table>

2.5 Project Seminars
### Module name
Project Seminar Application in High-Voltage Technology

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2070</td>
<td>8 CP</td>
<td>240 h</td>
<td>195 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
</tr>
</tbody>
</table>

### Content
Realization of a Project from the Design to the Implementation of High Voltage Setups

### Learning objectives / Learning Outcomes
The students can apply the methodology of design and development from the very first customer requirements specification up to design and type tests and documentation of equipment in high-voltage technology. They have successfully experienced team work and self-independently developed, built and tested a real device from the beginning.

### Recommended prerequisite for participation
High-voltage technology I and II, Power Laboratory I or II

### Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### Usability of this module
MSc ETiT, MSc Wi-ETiT

### References
depending on actual project

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-2070-pj</td>
<td>Project Seminar Application in High-Voltage Technology</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

### Instructor
Prof. Dr.-Ing. Volker Hinrichsen
## Module name
Project Seminar Automatic Control Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2080</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Jürgen Adamy</td>
</tr>
</tbody>
</table>

### 1 Content
The students work in small groups, supervised by a scientific staff member, on individual problems taken from the field of automatic control. A compulsory training course is part of the project course and will cover the topics 1. team work and project management, 2. professional presentation skills, and 3. scientific writing skills.

### 2 Learning objectives / Learning Outcomes
After attending the project course, a student is capable of: 1. planning a small project, 2. organizing the work within a project team, 3. searching for scientific background information on a given project, 4. creating ideas on how to solve problems arising in the project, 5. presenting the results in a scientific report, and 6. giving a talk on the results of the project.

### 3 Recommended prerequisite for participation

### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100%)

### 6 Usability of this module
MSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

### 7 References
Training course material

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2080-pj</td>
<td>Project Seminar Automatic Control Systems</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jürgen Adamy
### Module name
Project Seminar Design for Testability

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2130</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Prof. Dr.-Ing. Klaus Hofmann</td>
</tr>
</tbody>
</table>

1. **Content**
   - Learning advanced Methods for Testing Microchips after Manufacturing and Practical Application in small Design Scenarios, Final Presentation

2. **Learning objectives / Learning Outcomes**
   - Learning advanced Methods for Testing Microchips after Manufacturing and Practical Application in small Design Scenarios, Final Presentation

3. **Recommended prerequisite for participation**
   - Lecture “Advanced Digital Integrated Circuit Design”

4. **Form of examination**
   - Module final exam: (Study achievements, Optional, standard grading system)

5. **Grading**
   - Module final exam: (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**
   - MSc ETiT, MSc Wi-ETiT, MSc iCE, MSc iST, MSc MEC, MSc EPE

7. **References**
   - Slide Copies

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ho-2130-pj</td>
<td>Project Seminar Design for Testability</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>
Module name
Real-Time System Development Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2070</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr. rer. nat. Andreas Schürr

1 Content
Practical programming experience with C/C++
Software development under time and memory constraints
Hands-on experience documenting and testing a non-trivial system
Hands-on experience using SCM (source code management) systems, time management tools and other project management tools.
Team meetings, time planning and management,
Presentation skills

2 Learning objectives / Learning Outcomes
The student gains practical experience in the software development of embedded systems. He/She learns to work and function in a team, and to analyze and solve a non-trivial task. Moreover, students exercise using theoretical knowledge in the group (e.g. from lectures like real-time systems, software engineering – introduction, C++ programming lab) to solve a concrete and practical problem.
Students that have successfully completed this seminar are able to independently organize and set-up a non-trivial software project and function in a team to analyze and solve a certain task. Attendees gain the following skills in detail:
Realistic time and resource management (project management)
Experience with tools for version control and change/configuration management
Development of hardware/software systems with C/C++ under important constraints of embedded systems.
Planning and execution of quality assurance measures
Collaboration and communication in and between teams

3 Recommended prerequisite for participation
ETiT/DT, WI-ET/DT und iST: Basic software technology knowledge and advanced knowledge of object-oriented programming languages (especially C++)
Preferred: Basic knowledge of the development of real-time systems.
ETiT/AUT, MEC: Preferred: Regelungstechnik II und Digitale Regelungssysteme

4 Form of examination
Module final exam:
• Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, BSc iST

7 References
www.es.tu-darmstadt.de/lehre/projektseminar-echtzeitsysteme-ss/

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2070-pj</td>
<td>Real-Time System Development Lab</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr. rer. nat. Andreas Schürr

2.5 Project Seminars 286
<table>
<thead>
<tr>
<th><strong>Module name</strong></th>
<th>Energy Converters and Electric Drives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Nr.</strong></td>
<td>18-bi-2130</td>
</tr>
<tr>
<td><strong>Credit Points</strong></td>
<td>6 CP</td>
</tr>
<tr>
<td><strong>Workload</strong></td>
<td>180 h</td>
</tr>
<tr>
<td><strong>Self study</strong></td>
<td>135 h</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Cycle offered</strong></td>
<td>WiSe/SoSe</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>German and English</td>
</tr>
<tr>
<td><strong>Module owner</strong></td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
</tbody>
</table>

### 1 Content
From the topics of proposed scientific theses, subtasks are derived. Groups of two to four students will work on these subtasks under supervision of a tutor. The focus of the work can be either theoretical or experimental and contains scientific problems in the field of electric energy conversion and electric drives. For study program Mechatronics this corresponds to the Advanced Design Project.

### 2 Learning objectives / Learning Outcomes
Energy Converters, Electric Drives, Control of Electric Drives, Teamwork, Writing Scientific Reports, Presentation

### 3 Recommended prerequisite for participation
Fundamentals on Electrical Engineering, Three-phase Systems, Mechanics; Lecture „Electrical Machines and Drives“

### 4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

### 5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

### 6 Usability of this module
MSc MEC, MSc ETIT, MSc EPE

### 7 References
Depending on the project task; manuscripts from the lectures „Electrical Machines and Drives“, „Motor development for electric Drive Systems“, „Regelungstechnik 1“

### Courses

<table>
<thead>
<tr>
<th><strong>Course Nr.</strong></th>
<th>18-bi-2130-pj</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course name</strong></td>
<td>Energy Converters and Electric Drives</td>
</tr>
<tr>
<td><strong>Instructor</strong></td>
<td>Prof. Dr. techn. Dr.h.c. Andreas Binder</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Project Seminar</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>3</td>
</tr>
</tbody>
</table>
Project seminar Applications of Lighting Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2051</td>
<td>5 CP</td>
<td>150 h</td>
<td>105 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

**Language**
German and English

**Module owner**
Prof. Dr.-Ing. Khanh Quoc Tran

1 **Content**
The project seminar deals with the following subjects: automotive lighting, interior lighting, exterior lighting; generation, perception and cognition of the visual stimulus (luminaires, displays, projection); LED/OLED technology; physical and psychophysical light measurement; illuminating engineering, color perception.

2 **Learning objectives / Learning Outcomes**
The objective of this project seminar is the practice oriented implementation of the material learned during the lectures in form of a project work. Via communication of the interdisciplinary way of thinking of the lighting engineer, students should carry out autonomous project work on their own or in a team.

3 **Recommended prerequisite for participation**
Lighting Technology I-II (desireable)

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
MSc ETiT, MSc iST, MSc WI-ETiT, MSc MEC, MSc MPE, MSc Phys

7 **References**
Lecture notes of Lighting Technology I (Khanh); Lecture slides of our Laboratory; Book “LED Lighting: Technology and Perception” (Khanh et al., Wiley); Book „Farbwiedergabe“ (Khanh et al., Pflaum-Verlag); specific literature depending on the topic, publications.

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-kh-2051-pj</td>
<td>Project seminar Applications of Lighting Engineering</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Khanh Quoc Tran

2.5 Project Seminars
Module name
Project Course Automotive Mechatronics

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2080</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Ulrich Konigorski

Content
Teams of 2 – 4 students work on different engineering projects in the field of mechatronics under the guidance of a project coordinator from the institute.

The projects mainly cover the following subject areas:
- Modelling and identification of mechatronic systems
- Intelligent and adaptive control
- Digital control
- Supervision and fault diagnosis of mechatronic systems
- Application of mechatronic actuators

The main application areas are automotive engineering, internal combustion engines and medical technology.

Learning objectives / Learning Outcomes
After completing the project the students will be familiar with the individual steps of investigating an engineering project in the field of mechatronics. This includes in particular the compilation of a system specification as well as critical discussions and systematic selection of appropriate mechatronic solutions and their real technical implementation. Doing so the students learn the practical application of engineering methods taught in the lectures “System Dynamics and Control Systems I” and “Modelling and Simulation” to real world problems. Additionally, in this project course the students are supposed to improve their professional skills. These skills include e.g. teamwork, presentation techniques and systematic information retrieval.

Recommended prerequisite for participation
Lecture “System Dynamics and Control Systems I”
Lecture “Modelling and Simulation”

Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

Usability of this module
MSc ETiT, MSc MEC

References
Handouts will be distributed at start of the project (e.g. Hints for writing a project documentation, etc.)
Isermann: Mechatronische Systeme – Grundlagen, Springer

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2080-pj</td>
<td>Project Course Automotive Mechatronics</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. (em.) Dr. Rolf Isermann</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Module name

**Project Seminar MFT**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-2110</td>
<td>7 CP</td>
<td>210 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

### Language

<table>
<thead>
<tr>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
</tr>
</tbody>
</table>

### Content

Consists of “Product Development Methodology I” and “Proseminar ETIT Option MPE”. Intense theoretical and practical engagement with development methodology as an individual, but also within a project group at a specific didactic meaningful example.

### Learning objectives / Learning Outcomes

Students learn the five major stages of development methodology and apply it to a specific development project. In addition, tools for project planning and resource allocation, issues and assistance for productive team work and knowledge to successfully create technical reports and presentations are learned and trained.

### Recommended prerequisite for participation


### Form of examination

Module accompanying exam:
- [18-sl-1021-pj] (Study achievements, Optional, Standard BWS)
- [18-sl-1000-ps] (Study achievements, Optional, Standard BWS)

### Grading

Module accompanying exam:
- [18-sl-1021-pj] (Study achievements, Optional, weighting: 5)
- [18-sl-1000-ps] (Study achievements, Optional, weighting: 2)

### Usability of this module

MSc MEC

### References


### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1021-pj</td>
<td>Product Development Methodology I</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-1000-ps</td>
<td>Proseminar ETIT Option MPE</td>
<td>Introductory Seminar Course</td>
<td>2</td>
</tr>
<tr>
<td>Instructor</td>
<td>Prof. Dr.-Ing. Helmut Schlaak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Module name
Model-Based Software Development Lab

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2030</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr. rer. nat. Andreas Schürr

1. **Content**
In this course, students learn the model-based software development technique in the context of annually changing application areas and software development tasks. These tasks include the definition of a domain-specific language with analysis tools and code generators as well as the development of a concrete application with these tools. Usually mixed teams (of ETiT, iST and Computer Science students) perform the whole development cycle from project planning to acceptance test. The supervisors act primarily as “client” next to their advisor role. The focus is laid on Software Analysis and Design tasks, whereas Software Quality Assurance plays a minor role.

2. **Learning objectives / Learning Outcomes**
Students having successfully participated in this project seminar, are able to autonomously organize and perform a smaller model-based software development project for a given problem. The participants acquire the following skills:
- Goal-oriented literature research
- Client-oriented creation of requirements specification
- Daily application of version-, configuration- and change management tools
- Creation of executable models in the context of existing software architectures
- Improved presentation techniques
- Cooperation and communication with team members

3. **Recommended prerequisite for participation**
Basic knowledge of software engineering techniques and knowledge of an object-oriented programming language

4. **Form of examination**
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5. **Grading**
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6. **Usability of this module**
MSc ETiT, MSc iST, MSc Wi-ETiT, MSc Informatik

7. **References**
http://www.es.tu-darmstadt.de/lehre/mse/

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-su-2030-pj</td>
<td>Model-Based Software Development Lab</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

**Instructor**
Prof. Dr. rer. nat. Andreas Schürr

---

2.5 Project Seminars 291
Module name
Multimedia Communications Project Seminar II

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2080</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German and English

Module owner
Prof. Dr.-Ing. Ralf Steinmetz

Content
The course deals with cutting edge scientific and development topics in the area of multimedia communication systems. Besides a general overview it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics:

- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia / e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Applications for distributed workflows

Learning objectives / Learning Outcomes
The ability to solve and evaluate technical and scientific problems in the area of design and development of future multimedia communication networks and applications using state of the art scientific methods shall be acquired. Acquired competences are:

- Searching and reading of project relevant literature
- Design of complex communication applications and protocols
- Implementing and testing of software components for distributed systems
- Application of object-oriented analysis and design techniques
- Acquisition of project management techniques for small development teams
- Systematic evaluation and analyzing of technical and scientific experiments
- Writing of software documentation and project reports
- Presentation of project advances and outcomes

Recommended prerequisite for participation
Keen interest to develop and explore challenging solutions and applications in cutting edge multimedia communications systems using scientific methods. Further we expect:

- Solid experience in programming Java and/or C (C/C++)
- Solid knowledge in object oriented analysis and design
- Basic knowledge of design patterns, refactoring and project management
- Solid knowledge in computer communication networks are recommended
- Lectures in Communication Networks I (II, III, or IV) are an additional plus

Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

Usability of this module

2.5 Project Seminars 292
7 References

Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Erich Gamma, Richard Helm, Ralph E. Johnson: "Design Patterns: Objects of Reusable Object Oriented Software" (ISBN 0-201-63361-2)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2080-pj</td>
<td>Multimedia Communications Project Seminar II</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor

Prof. Dr.-Ing. Ralf Steinmetz
### Module name

**Project Course Practical Application of Mechatronics**

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2130</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>WiSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

1. **Content**  
   Teams of 2-4 students work on different mechatronic projects under the guidance of a project coordinator from the institute. The projects mainly cover the following subject areas:
   - Modeling, analysis, and design of mechatronic systems
   - Robust control design
   - System analysis, supervision and fault diagnosis
   - Modeling and identification

   Application areas are mechatronic actuators, machine tools, production lines, test benches, automobiles, quadrocopters.

2. **Learning objectives / Learning Outcomes**  
   After completing the project, the students will be familiar with the individual steps of investigating a mechatronic project. This includes in particular the compilation of a system specification as well as critical discussions and systematic selection of appropriate mechatronic solutions and their real technical implementation. Doing so, the students learn the practical application of mechatronic methods taught in the lectures to real-world problems. Additionally, in this project course, the students are supposed to improve their professional skills. These skills include e.g. teamwork, presentation techniques and systematic information retrieval.

3. **Recommended prerequisite for participation**  

4. **Form of examination**  
   Module final exam:
   - Module exam (Study achievements, Optional, standard grading system)

5. **Grading**  
   Module final exam:
   - Module exam (Study achievements, Optional, weighting: 100 %)

6. **Usability of this module**  
   MSc ETiT, MSc MEC, MSc iST

7. **References**  
   Handouts will be distributed at start of the project (e.g. hints for writing project documentation, etc.)

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2130-pj</td>
<td>Project Course Practical Application of Mechatronics</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

**Instructor**  
Prof. Dr.-Ing. Ulrich Konigorski
# Module name

Project Course Control Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2090</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

## Content

Teams of 2 - 4 students work on different control engineering projects under the guidance of a project coordinator from the institute. The projects mainly cover the following subject areas:

- Modelling, analysis and design of multivariable control systems
- Modelling, analysis and design of distributed parameter systems
- Robust control design
- System analysis, supervision and fault diagnosis
- Modelling and identification

Application areas are machine tools, production lines, test benches, process control, automobiles.

## Learning objectives / Learning Outcomes

After completing the project the students will be familiar with the individual steps of investigating a control engineering project. This includes in particular the compilation of a system specification as well as critical discussions and systematic selection of appropriate control engineering solutions and their real technical implementation. Doing so the students learn the practical application of control engineering methods taught in the lecture “System Dynamics and Control Systems I” to real world problems. Additionally, in this project course the students are supposed to improve their professional skills. These skills include e.g. teamwork, presentation techniques and systematic information retrieval.

## Recommended prerequisite for participation

Lecture “System Dynamics and Control Systems I”

## Form of examination

Module final exam:

- Module exam (Study achievements, Optional, standard grading system)

## Grading

Module final exam:

- Module exam (Study achievements, Optional, weighting: 100 %)

## Usability of this module

MSc ETiT, MSc MEC

## References

Handouts will be distributed at start of the project (e.g. Hints for writing a project documentation, etc.)

## Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2090-pj</td>
<td>Project Course Control Engineering</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
Module name
Project Course Automotive Control Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2120</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Module owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

1 Content
Teams of 2 – 4 students work on different engineering projects in the field of mechatronics under the guidance of a project coordinator from the institute.
The projects mainly cover the following subject areas:
- Modelling and identification of mechatronic systems
- Intelligent and adaptive control
- Digital control
- Supervision and fault diagnosis of mechatronic systems
- Application of mechatronic actuators

The main application areas are automotive engineering, internal combustion engines and electrical drives (hybrid)

2 Learning objectives / Learning Outcomes
After completing the project the students will be familiar with the individual steps of investigating an engineering project in the field of mechatronics. This includes in particular the compilation of a system specification as well as critical discussions and systematic selection of appropriate mechatronic solutions and their real technical implementation. Doing so the students learn the practical application of engineering methods taught in the lectures “System Dynamics and Control Systems I” and “Modelling and Simulation” to real world problems. Additionally, in this project course the students are supposed to improve their professional skills. These skills include e.g. teamwork, presentation techniques and systematic information retrieval.

3 Recommended prerequisite for participation
Lecture “System Dynamics and Control Systems I”
Lecture “Modelling and Simulation”

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC

7 References
Handouts will be distributed at start of the project (e.g. Hints for writing a project documentation, etc.)
Isermann: Mechatronische Systeme – Grundlagen, Springer

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2120-pj</td>
<td>Project Course Automotive Control Engineering</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. (em.) Dr. Rolf Isermann
Module name
Projektseminar Rekonfigurable Systems

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2040</td>
<td>6 CP</td>
<td>180 h</td>
<td>135 h</td>
<td>1</td>
<td>WiSe/SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Christian Hochberger

Content
Students will work in small groups in this course. Topics and application context will be defined individually for each group. All projects will follow the same approach. At first, the given problem will be described in a programmatic way. Following, it will be implemented by a reconfigurable system. Depending on the nature of the application, either predefined architectures will be used, parameterizable architectures will be adapted to the needs of the application or new architectures may be designed. The programmatic description will now be mapped (semi-)automatically to the chosen architecture with the help of the supporting tools. Usually, this requires to rewrite the programmatic description to better suit the tools. Finally, the solution will be evaluated using some benchmark data sets.

Learning objectives / Learning Outcomes
Successful students will know how to use reconfigurable systems within a given application context. They can use tools to program these systems and know how to map an application onto a given reconfigurable architecture. They are capable to evaluate the performance critical parts of an application. They understand the implications of different coding styles for a particular task.

Recommended prerequisite for participation
- Knowledge of reconfigurable devices (cf. course computer systems II)
- Knowledge of computer architecture (cf. course computer systems I)
- Solid programming skills (either in C or Java depending on the application scenario).

Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

Usability of this module
MSc ETiT, MSc iST, MSc Informatik, MSc iCE

References
Will be made available through the Moodle page for this course.

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hb-2040-pj</td>
<td>Projektseminar Rekonfigurable Systems</td>
<td>Project Seminar</td>
<td>3</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Christian Hochberger
Module name
Project Seminar Robotics and Computational Intelligence

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2070</td>
<td>8 CP</td>
<td>240 h</td>
<td>180 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Jürgen Adamy

1 Content
The following topics are taught in the lecture: 1. Industrial robots, 1a. Types and applications, 1b. Geometry and kinematics, 1c. Dynamic model, 1d. Control of industrial robots, 2. Mobile robots, 2a. Types and applications, 2b. Sensors, 2c. Environmental maps and map building, 2d. Trajectory planning. Group projects are arranged after the lectures in order to apply the taught material in practical exercises.

2 Learning objectives / Learning Outcomes
After attending the lecture, a student is capable of: 1. recalling the basis elements of industrial robots, 2. recalling the dynamic equations of industrial robots and be able to apply them to describe the dynamics of a given robot, 3. stating model problems and solutions to standard problems in mobile robotics, 4. planning a small project, 5. organizing the work load in a project team, 6. searching for additional background information on a given project, 7. creating ideas on how to solve problems arising in the project, 8. writing an scientific report about the outcome of the project 8. presenting the results of the project.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

7 References
Adamy: Lecture notes (available for purchase at the FG office)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ad-2070-pj</td>
<td>Project Seminar Robotics and Computational Intelligence</td>
<td>Project Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Jürgen Adamy
2.6 Research Seminar

<table>
<thead>
<tr>
<th>Module name</th>
<th>Research Seminar “Advanced Methods in Control Theory”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Nr.</td>
<td>18-ko-2100</td>
</tr>
<tr>
<td>Credit Points</td>
<td>4 CP</td>
</tr>
<tr>
<td>Workload</td>
<td>120 h</td>
</tr>
<tr>
<td>Self study</td>
<td>60 h</td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
</tr>
</tbody>
</table>

1 Content
Several Topics from the current research and the advances controller design are presented and treated by the students with the help of examples. Examples for topics are:
- Robust Controller Design
- Analysis and Control of Distributed Systems
- Geometric Controller Design
- Network Control Systems
- Multi-Agents Systems
- Design of Linear and Nonlinear Descriptor Systems

2 Learning objectives / Learning Outcomes
The students will be able to use advanced controller design methods and will gain insight into the current research.

3 Recommended prerequisite for participation
Knowledge of control theory from "System Dynamics and Control Systems III") and “Controller Design for Multivariable Systems in State Space”.

4 Form of examination
Module final exam:
- Module exam (Study achievements, Oral Examination, duration: 30 min, standard grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Oral Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC

7 References
J. Ackermann: Robuste Regelung. Springer
Skogestad, “Multivariable Feedback Control”, Wiley
Dai, Singular Control Systems, Springer
Nijmeijer, “Nonlinear Dynamical Control Systems”, Springer

Courses
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-2100-fs</td>
<td>Research Seminar “Advanced Methods in Control Theory”</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Ulrich Konigorski

<table>
<thead>
<tr>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Seminar</td>
<td>4</td>
</tr>
</tbody>
</table>
### Module name
Railway Vehicle Engineering

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2050</td>
<td>3 CP</td>
<td>90 h</td>
<td>45 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**  
German

**Module owner**  
Prof. Dr. techn. Dr.h.c. Andreas Binder

### Content
From the comprehensive and interdisciplinary domain of the railway technology (vehicle technology, signal and safety technology, construction engineering and railway operating technology) the lecture picks out the domain of the automotive engineering with the emphasis of the mechanical part. It offers an interrelated introduction into selected chapters of the rail vehicle engineering with special emphasis in the railway-specific technical solutions and procedures. The lecture is divided into 7 chapters, whereby chapters 1-4 cover the theoretical basic topics and chapters 5-7 present the fundamental components of the rail vehicle. In a one-day excursion, it is possible to gain insights into the production of modern rail vehicles. Participation is voluntary.

### Learning objectives / Learning Outcomes
Basic understanding of mechanical parts of railways and their components.

### Recommended prerequisite for participation
Bachelor in Electrical Engineering, Mechatronics or Mechanical Engineering.

### Form of examination
Module final exam:
- Module exam (Technical examination, Optional, standard grading system)

### Grading
Module final exam:
- Module exam (Technical examination, Optional, weighting: 100%)

### Usability of this module
MSc ETiT, MSc MEC, MSc EPE, MSc WI-ETiT

### References

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-bi-2050-vl</td>
<td>Railway Vehicle Engineering</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>18-bi-2050-ek</td>
<td>Railway Vehicle Engineering (Excursion)</td>
<td>Field Trip</td>
<td>1</td>
</tr>
</tbody>
</table>

**Instructor**  
Dr.-Ing. Gerd Meyer
2.8 Colloquies

**Module name**
Industrial Colloquium

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2290</td>
<td>2 CP</td>
<td>60 h</td>
<td>30 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

**Language**
German

**Module owner**
Prof. Dr.-Ing. Ralf Steinmetz

1 **Content**
To get an idea about current trends in industry. In addition, to give a glimpse of job opportunities the industry will provide after graduation. Acquired competences are:
- Active knowledge about industry trends and applications in multimedia communications
- Build contact with persons from various important companies
- Presentation skills improvement

2 **Learning objectives / Learning Outcomes**
Today, the Internet is much more than just a browser window on your desktop-PC. It is a part of our everyday life and has become ubiquitous thanks to smartphones, tablet-PCs and laptops. This pervasiveness of the Internet requires tremendous effort on the provider side. This is due to the fact that the Internet itself is a communication system with a vast number of mechanisms running on different functional layers. With the rapid increase of mobile devices, traffic consumption, and the sheer number of users, many of those mechanisms reach their limits. This problem becomes visible to the end user, if, for example, large crowds of people suddenly overload the mobile communication infrastructure.

With the recently established collaborative research center MAKI (Multi-Mechanismen-Adaption für das künftige Internet) scientists of TU Darmstadt study the possibilities of coordinated and automated transitions between different mechanisms of a communication system. Thereby, the Future Internet will be able to react to changes by, for example, switching from the mobile communication infrastructure to a local ad-hoc network between users if the demand by users exceeds the resources of the available infrastructure.

In this year’s industrial colloquium, partners from the industry present their visions, challenges and solutions regarding the Future Internet. Additionally, researchers from TU Darmstadt provide insights into current scientific work in the context of the collaborative research center MAKI.

3 **Recommended prerequisite for participation**
Mandatory: Basic knowledge in Information Systems and Communication Systems. The student has to be capable to understand the technical aspects and to summarize them in a written report as a short paper.

4 **Form of examination**
Module final exam:
- Module exam (Study achievements, Optional, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Study achievements, Optional, weighting: 100 %)

6 **Usability of this module**
MSc EITI, MSc iST, MSc ICE

7 **References**

**Courses**

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sm-2290-ko</td>
<td>Industrial Colloquium</td>
<td>Colloquy</td>
<td>2</td>
</tr>
</tbody>
</table>
3 Interdisciplinary Modules of FB 18

Module name
Management for Engineers

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-4010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Helmut Schlaak

1 Content
The lecture covers the following topics: product development process, technology life cycle, organization of companies, management methodology, project management, guidance and leadership behaviour, basics in cost calculation, value analysis and value engineering, quality management and quality assurance, communication within a company.

2 Learning objectives / Learning Outcomes
The student is able to point out the modern management methods used in a company, define the technology life cycle, give examples of management issues and rate them, perform a costing and explain quality assurance by an example.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
MSc ETiT, MSc MEC, MSc iCE, MSc WI-ETiT

7 References
Script for lecture: Management für Ingenieure (in german)

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-sl-4010-vl</td>
<td>Management for Engineers</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor
Prof. Dr.-Ing. Helmut Schlaak
Module name
Standardization, Testing and Approvals in the Electrotechnical Area

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-4010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language
German

Module owner
Prof. Dr.-Ing. Gerd Griepentrog

1 Content
In the European Union (EU), the fundamental requirements for electrical equipment, such as safety and electromagnetical compatibility (EMC) including functionality, are stipulated in EC Directives and by national implementation in laws and decrees. These requirements take shape in harmonized standards. The manufacturer or his authorized agent resident in the EU or, as the case may be, the user of the equipment has to show compliance with the requirements by means of
• Own tests or
• Tests carried out by an independent neutral testing laboratory.

During the lecture, these criteria are considered with respect to the following topics:
• Product safety law (ProtSG)
• Energy promotion law (EnWG)
• Law on electromagnetical compatibility of equipment (EMVG)
• Telecommunications law (TKG)
• X-ray decree (RöV)
• Explosion-protection decree
• Standardization by the German Electrotechnical Commission of DIN and VDE (DKE)
• Standardization:
  – In Europe by CENELEC (= European Committee of Electrotechnical Standardization)

• Application of regulation on the basis of case studies:
  – Case study 1: Functional Safety
  – Case Study 2: Protection against electric shock

• Separation of device and product standards (which are taught in the course) against grid codes such as BdEW or Entso-e Grid Code

2 Learning objectives / Learning Outcomes
Participants of the course will be aware of connections between basic requirements given by law and technical standards for research and development of electrotechnical equipment. As an outcome the participants will know the basic requirements for safety and reliability of such products.

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
• Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 Grading
Module final exam:
• Module exam (Technical examination, Written Examination, weighting: 100 %)

6 Usability of this module
BSc/MSc ETiT, MEC, iST

7 References
- Link für EG-Richtlinien: eur-lex.europa.eu/de/index.htm

### Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-gt-4010-vl</td>
<td>Standardization, Testing and Approvals in the Electrotechnical Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr.-Ing. Gerhard Imgrund</td>
<td>Lecture</td>
<td>2</td>
</tr>
</tbody>
</table>
Module name
Patents – How to protect technical inventions

<table>
<thead>
<tr>
<th>Module Nr.</th>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-3010</td>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Language</td>
<td>Module owner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>Prof. Dr.-Ing. Ulrich Konigorski</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 **Content**
Within the scope of this lecture aspects of national and international patent law as well as aspects of the law on employee will be treated as follows:
- German, European and international filing procedures and their legal prerequisites (formal and substantive patent law)
- Enforcement of technical property rights
- Infringement of technical property rights
- Law on employee invention – rights and obligations of employees and employers

2 **Learning objectives / Learning Outcomes**
Students will be able to deal with basic issues relating to patent law. They will get valuable insights and practical know-how concerning the implementation and enforcement of patents.
The capability to innovate is a decisive key factor in today's world of business and work and plays a significant role for our economic success. The protection of such technical innovations is therefore of increasing importance. Engineers have to deal with issues related to patent law on a regular basis such as the implementation and enforcement of industrial property rights or the law on employee invention. Within the scope of this lecture students will learn the basics of national and international patent law while focusing on problems that may occur in the professional everyday life of a patent attorney.

3 **Recommended prerequisite for participation**

4 **Form of examination**
Module final exam:
- Module exam (Technical examination, Written Examination, duration: 90 min, standard grading system)

5 **Grading**
Module final exam:
- Module exam (Technical examination, Written Examination, weighting: 100%)

6 **Usability of this module**
MSc ETiT, MSc MEC

7 **References**
- German Utility Model Act „Gebrauchsmustergesetz (GbmG)“ - www.gesetze-im-internet.de/gebrmg/index.html
- German Law on Employee Invention „Arbeitnehmererfindergesetz (ArbEG)“ - www.gesetze-im-internet.de/arbnerfg/index.html

Students will find a compilation of the relevant legal texts in the following book:
<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-ko-3010-vl</td>
<td>Patents – How to protect technical inventions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Ing. Sebastian Clever</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Module name</td>
<td>What is behind all this?</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------</td>
<td></td>
</tr>
<tr>
<td>Module Nr.</td>
<td>18-hi-3002</td>
<td></td>
</tr>
<tr>
<td>Credit Points</td>
<td>2 CP</td>
<td></td>
</tr>
<tr>
<td>Workload</td>
<td>60 h</td>
<td></td>
</tr>
<tr>
<td>Self study</td>
<td>30 h</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cycle offered</td>
<td>SoSe</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
<td></td>
</tr>
<tr>
<td>Module owner</td>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>Content</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Learning objectives / Learning Outcomes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Recommended prerequisite for participation</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>Form of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Module final exam:</td>
</tr>
<tr>
<td></td>
<td>• Module exam (Study achievements, Colloquium, pass/fail grading system)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Module final exam:</td>
</tr>
<tr>
<td></td>
<td>• Module exam (Study achievements, Colloquium, weighting: 100%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th>Usability of this module</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>7</th>
<th>References</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Nr.</td>
</tr>
<tr>
<td>18-hi-3002-ko</td>
</tr>
<tr>
<td>Instructor</td>
</tr>
<tr>
<td>Prof. Dr.-Ing. Volker Hinrichsen</td>
</tr>
</tbody>
</table>
Module name
What is behind all this?

Module Nr.  
18-hi-3003  

<table>
<thead>
<tr>
<th>Credit Points</th>
<th>Workload</th>
<th>Self study</th>
<th>Duration</th>
<th>Cycle offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 CP</td>
<td>90 h</td>
<td>60 h</td>
<td>1</td>
<td>SoSe</td>
</tr>
</tbody>
</table>

Language  
German

Module owner  
Prof. Dr.-Ing. Volker Hinrichsen

1 Content

2 Learning objectives / Learning Outcomes

3 Recommended prerequisite for participation

4 Form of examination
Module final exam:
- Module exam (Study achievements, Domestic Work, standard grading system)
- Module exam (Study achievements, Colloquium, pass/fail grading system)

5 Grading
Module final exam:
- Module exam (Study achievements, Domestic Work, weighting: 100%)
- Module exam (Study achievements, Colloquium, weighting: 0%)

6 Usability of this module

7 References

Courses

<table>
<thead>
<tr>
<th>Course Nr.</th>
<th>Course name</th>
<th>Type</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-hi-3002-ko</td>
<td>What is behind all this?</td>
<td>Colloquy</td>
<td>2</td>
</tr>
</tbody>
</table>

Instructor  
Prof. Dr.-Ing. Volker Hinrichsen