



Modules MSc Communications Engineering (MSCE) PO20181 (start WS18/19)

| Module ID | Module | Lecturer | Semester | ECTS | Focus on |
|-----------|--------|----------|----------|------|----------|
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Core Modules Communications Systems (CS): at least 10 Credits

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|---------|--|-------------|-------|---|----|
| EI70330 | Data Networks | Kellerer | WS | 5 | |
| EI70320 | Channel Coding | Wachter-Zeh | WS/SS | 5 | |
| EI70350 | Information Theory | Kramer | WS | 5 | |
| EI70240 | Statistical Signal Processing ¹ | Utschick | SS | 5 | CS |
| EI7432 | System Aspects in Communications | Viering | WS | 5 | |

Core Modules Communication Electronics (CE): at least 10 Credits

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|---------|-------------------------------------|-------------|-------|---|----|
| EI70510 | Analog and Mixed-Signal Electronics | Brederlow | WS | 5 | |
| EI70610 | Electronic Design Automation | Gräb / Li | WS | 5 | |
| EI70530 | Embedded Systems and Security | Sigl | WS/SS | 5 | |
| EI7355 | Nanosystems | Becherer | WS/SS | 5 | CE |
| EI7384 | System-on-Chip Technologies | Herkersdorf | WS | 5 | |

Elective Modules Advanced Topics: at least 5 Credits

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|---------|---|-----------------|----|---|----|
| EI79001 | Advanced Topics in Communications Systems | Guest Professor | SS | 5 | CS |
| EI79002 | Advanced Topics in Communications Electronics | Guest Professor | SS | 5 | CE |

Electives: 28 Credits

Fewer electives, if you have passed more core modules or elective modules advanced topics, in total 53 credits:

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|------------|---|------------|-------|---|----|
| CIT4330008 | 5G New Radio Communications: Physical Layer Channels and Procedures | Boche | WS/SS | 5 | |
| EI7433 | Adaptive and Array Signal Processing ² | Ivrlac | WS | 5 | |
| EI71070 | Advanced Cryptographic Implementations | De Santis | SS | 5 | |
| EI71105 | Advanced Topics in IoT Security | Steinhorst | SS | 5 | CE |
| EI71077 | Algorithms in Quantum Theory | Kramer | WS/SS | 6 | CS |
| EI7523 | Analog Bipolar Electronics: Devices, Simulation and Circuits | Brederlow | WS | 3 | CE |
| EI7450 | Analysis, Modelling and Simulation of Communication Networks | Kellerer | SS | 6 | CS |
| CIT4430007 | Antenna and Radar Cross-Section Measurement and Processing Techniques | Eibert | WS | 5 | |
| EI73081 | Antennas and Wave Propagation | Eibert | SS | 5 | CS |
| EI71086 | Applied Machine Intelligence | Diepold | SS | 9 | CS |

¹ New core module in summer semester 2023

² Elective module summer semester 2023

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|------------|---|--------------|----------|------|----------|
| EI7411 | Channel Codes for Iterative Decoding | Liva | SS | 5 | CS |
| EI7271 | Chip Multicore Processors | Herkersdorf | SS | 6 | CS/CE |
| EI70520 | Circuit Design for Security | Sigl | SS | 5 | |
| EI7440 | Circuit Theory and Communications | Ivrlac | WS | 5 | CS/CE |
| EI71108 | CMOS Analog-to-Digital Converters | Brederlow | SS | 5 | CE |
| EI74121 | Coded Modulation ³ | Bartz/Matuz | SS | 5 | CS |
| EI71087 | Coding Theory for Storage and Networks | Wachter-Zeh | SS | 5 | CS |
| EI71004 | Communication Acoustics | Seeber | WS | 6 | CS |
| EI7644 | Communication Network Reliability | Mas Machuca | SS | 5 | CS |
| EI73181 | Computational and Analytical Methods in Electromagnetics | Eibert | WS | 6 | CS/CE |
| EI74351 | Convex Optimization | Utschick | WS | 6 | CS |
| EI71067 | Digital Signal Processing for Optical Communication Systems | Fehenberger | SS | 5 | |
| EI71104 | Embedded System Design for Machine Learning | Schlichtmann | WS/SS | 6 | CE |
| CIT4330003 | Fast Secure and Reliable Coded Computing | Wachter-Zeh | WS | 5 | |
| EI70410 | High-Frequency Amplifiers and Oscillators | Eibert | SS | 5 | CE |
| EI70630 | HW/SW Codesign | Herkersdorf | WS/SS | 5 | CE |
| EI7341 | Image and Video Compression | Steinbach | SS | 5 | CS |
| CIT4430002 | Integrated Circuits for Radio Applications | Hagelauer | WS | 5 | |
| EI71083 | Intelligent Machine Design - Mechatronics Fundamentals | Haddadin | SS | 6 | CE/CS |
| EI71064 | Introduction to Quantum Networks | Nötzel | WS/SS | 5 | |
| EI71084 | IoT Security | Steinhorst | WS | 5 | CE |
| EI70360 | Machine Learning and Optimization | Heckel | WS | 5 | CS |
| EI71018 | Machine Learning for Communications | Kramer | WS | 5 | CS |
| EI71040 | Machine Learning: Methods and Tools | Wille | WS | 5 | CE |
| EI71059 | Mixed Integer Programming and Graph Algorithms for Engineering Problems | Schlichtmann | WS | 5 | CE |
| EI7436 | MIMO Systems | Joham | WS | 6 | CS |
| EI71095 | Multi-Criteria Optimization and Decision Analysis for Embedded Systems Design | Herkersdorf | WS | 5 | CE |
| EI70220 | Digital Signal Processing | Steinbach | WS/SS | 5 | CS |
| EI7352 | Multimedia Communications ⁴ | Steinbach | SS | 5 | CS |
| EI7353 | Multi-User Information Theory | Kramer | SS | 5 | CS |
| EI7356 | Network Planning | Schupke | WS | 5 | CS |
| EI7494 | Numerical Linear Algebra for Signal Processing | Utschick | SS | 6 | |
| EI5075 | Optical Communication Systems | Hanik | WS | 6 | CS |
| EI7633 | Optical Networks ⁵ | Mas Machuca | SS | 5 | CS |

³ will not be offered in summer semester 2023⁴ will not be offered in summer semester 2023⁵ will not be offered in summer semester 2023

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|------------|---|----------------------|----------|------|----------|
| EI74042 | Mathematical Methods of Circuit Design | Gräb | WS/SS | 5 | CE |
| EI70730 | Memory Technology for Data Storage | Kreupl | WS/SS | 5 | CE |
| EI7485 | Physical Principles of Electromagnetic Fields and Antenna Systems | Ivrlac | SS | 6 | CS |
| EI71029 | Physical Unclonable Functions | Sigl | WS | 5 | CE |
| EI71103 | Post Shannon Theory | Kramer | SS | 5 | CS |
| EI71073 | Quantum Computers and Quantum Secure Communications | Sepulveda | SS | 5 | CE |
| EI76471 | Quantum Information Theory | Boche | WS/SS | 5 | CS |
| EI71093 | Quantum Optomechanics | Weig | SS | 5 | CE |
| EI73761 | Radar Signals and Systems | Siart | WS | 5 | CS |
| EI0432 | Satellite Navigation | Günther | WS | 6 | CS |
| EI71060 | Security in Communications and Storage | Wachter-Zeh | WS | 5 | CS |
| EI70380 | Signal Processing and Machine Learning | Utschick | SS | 5 | CS |
| EI71068 | Solving Inverse Problems with Deep Learning | Heckel | SS | 6 | |
| EI70640 | Synthesis of Digital Systems | Müller-Gritschneider | WS/SS | 5 | CE |
| CIT4430001 | System Design for High-Frequency and High-Datarate Applications | Hagelauer | WS | 5 | |
| EI71013 | System Design for the Internet of Things | Steinhorst | SS | 5 | CE |
| EI5077 | System-on-Chip Platforms ⁶ | Herkersdorf | SS | 6 | CE |
| EI7624 | Techno-Economic Analysis of Telecommunication Networks | Mas Machuca | WS | 5 | CS |
| EI50141 | Testing Digital Circuits | Otterstedt | WS | 5 | CE |
| EI5052 | Time-Varying Systems and Computations | Diepold | WS | 6 | CE |
| EI70550 | Timing of Digital Circuits | Li | WS | 5 | CE |
| EI71075 | Wireless Communications | Kramer | WS | 5 | CS |

Laboratories: 12 Credits

| | | | | | |
|------------|--|------------|-------|---|----|
| CIT4310006 | 6G Business Modeling and Prototyping | Kellerer | SS | 9 | |
| EI5032 | Communications Lab | Kramer | WS | 6 | CS |
| EI72071 | Computational Haptics Laboratory | Steinbach | SS | 6 | CS |
| EI72561 | Convex Optimization Laboratory | Utschick | SS | 6 | CS |
| EI50881 | High-Frequency Circuit Laboratory | Eibert | WS/SS | 6 | CE |
| EI50291 | Image and Video Compression Lab | Steinbach | WS/SS | 6 | CS |
| EI78049 | IoT Remote Lab ⁷ | Steinhorst | WS/SS | 6 | |
| EI78060 | Lab CMOS A/D Converter Design | Brederlow | WS | 6 | CE |
| EI78064 | Lab CMOS Voltage Regulation Circuit Design | Brederlow | SS | 6 | CE |

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|------------|---|--------------|----------|------|----------|
| CIT4410013 | Laboratory Design of Integrated Analog and Mixed-Signal Circuits | Hagelauer | SS | 6 | |
| CIT4410011 | Lab Integrated Circuits for Radio Applications | Hagelauer | SS | 6 | |
| CIT4410012 | Laboratory on System Design for High-frequency and High-datarate Applications | Hagelauer | SS | 6 | |
| EI78031 | Practical Training Project Integrated Systems | Plattner | SS | 6 | CE |
| CIT4310003 | Programmable Communication Networks Lab | Kellerer | WS/SS | 6 | |
| EI5042 | Project Lab IC Design | Herkersdorf | WS/SS | 6 | CE |
| EI78033 | Projektpraktikum Audio-Signalverarbeitung ⁸ | Seeber | WS/SS | 6 | CE |
| EI78075 | Projektpraktikum Human Activity Understanding | Steinbach | WS/SS | 6 | CS |
| EI78071 | Projektpraktikum Nanomagnetische Bauelemente | Weig | WS/SS | 6 | |
| EI7493 | Signal Processing for Audio Technology | Seeber | SS | 8 | CS |
| EI5030 | Simulation of Optical Communication Systems Lab | Hanik | WS/SS | 6 | CS |
| EI5069 | Smart Card Lab | Sigl | WS/SS | 6 | CS/CE |
| EI78045 | Software Defined Radio Laboratory | Boche | WS/SS | 6 | |
| EI7402 | SystemC Lab | Herkersdorf | WS/SS | 6 | CE |
| EI7403 | VHDL System Design Lab | Schlichtmann | WS/SS | 6 | CE |
| EI7426 | Wireless Communications Laboratory | Kramer | SS | 5 | CS |
| EI50471 | Wireless Sensor Networks Laboratory | Kellerer | WS/SS | 6 | CS |

The labs count towards the final grade point average with their corresponding credit weight. For all labs at the department, there is always a special registration deadline.

Registration information for labs and details about introductory meetings are made available on the websites of the various chairs shortly before the beginning of each semester. So please check these websites.

Seminars: 5 Credits

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|---------|---|-------------|-------|---|----|
| EI73141 | Brain, Mind and Cognition (Seminar) | Diepold | WS | 5 | CS |
| EI77001 | Seminar Embedded Systems and Internet of Things | Steinhorst | WS/SS | 5 | CS |
| EI77009 | Seminar Machine Learning | Heckel | WS/SS | 5 | CS |
| EI77692 | Seminar Micro- and Nanosystems Technology | Hagelauer | SS | 5 | |
| EI77011 | Seminar Nano- & Optomechanical Quantum Technologies | Weig | WS/SS | 5 | CE |
| EI77015 | Seminar on Coding and Cryptography | Wachter-Zeh | WS/SS | 5 | CS |

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|-----------|--|--------------|----------|------|----------|
| EI77013 | Seminar on Digital Communications | Kramer | WS/SS | 5 | CS |
| EI77014 | Seminar on Optical Communications | Hanik | WS/SS | 5 | CS |
| EI5092 | Seminar on Security in Information Technology | Sigl | WS | 5 | CS/CE |
| EI5090 | Seminar on Signal Processing in Communications | Utschick | WS | 5 | CS |
| EI5091 | Seminar on Topics in Antennas and Propagation | Eibert | WS | 5 | CS/CE |
| EI5087 | Seminar on Topics in Communications Networking | Kellerer | WS | 5 | CS |
| EI77502 | Seminar on Topics in Electronic Design Automation | Schlichtmann | WS | 5 | CE |
| EI77501 | Seminar on Topics in Integrated Systems | Herkersdorf | WS | 5 | CE |
| EI77503 | Scientific seminar on structure, architecture and application of sensor circuits | Brederlow | WS/SS | 5 | CE |
| EI5084 | Seminar on Topics in Signal Processing | Steinbach | WS | 5 | CS |

Interdisciplinary Courses: 8 Credits

Recommended:

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|---------|------------------------------------|---------------------|-------|---|--|
| | German Language Course | TUM Language Center | WS/SS | 6 | |
| EI04004 | Strategic Management for Engineers | Sauerbrey | WS/SS | 3 | |

As interdisciplinary course, any TUM course on a topic different from electrical and computer engineering (no EIxx module number) and other universities can be taken. The courses can only be counted, if there is a confirmation of the course including the number of credits. Any language course (excepting English), offered by e.g. the TUM language center, can be counted as an interdisciplinary course. If you want to be sure, if your course will be counted, please contact the program manager. The grades of the interdisciplinary modules will not count toward your final grade.

Research Internship: 12 Credits

Duration and Timing

The research internship (in German so called Forschungspraxis) is a career-related, full-time (approx. 35-40 hours per week, depending on the company) professional experience at the university or in industry with a minimum length of 9 weeks. If required by industry, we can certify that 9 weeks are required as a mandatory research internship for your studies. Usually it is scheduled immediately after the second semester until the beginning of the third semester. Please consider the following suggested timeline:

| | |
|----------------------------|---|
| March | Start looking for research internship placement |
| End of July | Final Exams for semester 2 |
| August through mid-October | Research Internship |
| Mid-October | Semester 3 begins |
| End of October | Hand in the required paperwork |

Research Internship Arrangement & Registration

How to get an internship

Students must arrange for an internship themselves. The following guidelines have to be followed: In case you need a confirmation that a research internship is required by your curriculum, please contact us: msce@ei.tum.de

To find a research internship project, please contact the chairs directly. Some chairs list available projects on their website. If you want to do the research internship in industry, you have to find a professor at TUM who will supervise it. Please find a professor before signing any industry contract to avoid any inconvenience. Once you have found a research internship position, please report it to the program manager. You must write a technical report about your internship (approx. 1-2 pages per week). At the end of the research internship, you will present your results to the professor, followed by a short discussion.

Technical Report

At the end of your research internship, you must write a technical report that documents the work and presents the results. A good structure for an internship report is: cover and title page; abstracts; table of contents; introduction; problem definition; theory; implementation; testing for correctness of results, performance, usability, assessment; conclusions and ideas for future work; and references.

The total length of the report should be at least 1-2 pages per week.

You should also include one page of critical analysis (not simply a description) of the experience in terms of learning objectives and overall experience at the time of completion of the internship.