Study Guide

for the

Master's Programme

Advanced Signal Processing and Communications Engineering

Academic Year 2023/24

September 2023

Preface

This document is written to support the students of Advanced Signal Processing and Communications Engineering (ASC) at the FAU in organizing their studies and to provide some insight into this programme to prospective students and the generally interested public. As such, it describes the main characteristics of the programme, its scope, and its goals. As reference information, it includes an English description of the curriculum and the key elements of the applicable examination regulations for ASC students. The latter are based on the English-language programme-specific [examination regulation for the Master's Programme Advanced Signal Processing and Communications Engineering (ASC)](#) and the German-language general examination regulation of the Faculty of Engineering at the Friedrich-Alexander University Erlangen-Nürnberg (FAU). **Please note that the German versions of the examination regulations are the legally binding documents**. The study guide also includes relevant guidelines for using the services provided by the university and its associated institutions, e.g., the housing service of the Studentenwerk, an overview of need-to-know internet platforms and useful addresses.
The authors welcome feedback and suggestions for additions.

Erlangen, September 2023

Prof. Ralf Müller and Lena Borke-Weber

Content

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Chapter 1

ASC - The Master's Programme

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1.1 Concept

The ASC Master's study programme emphasizes fundamental concepts of modern technologies in the areas of signal processing, communications, machine learning and artificial intelligence. Via hands-on experiments and research projects, students can build a solid understanding in one or more technical subjects including communications, signal processing, and machine learning. ASC provides an unprecedented flexibility in terms of students' course schedules. Students plan their own schedules according to their interests, specializations, and research directions.

With our mentoring programme, they can choose a mentoring professor according to their preferred direction of study.

The four-semester curriculum includes three special events: A kick-off seminar right before the winter semester, a winter school between the first and second semester, and a summer school before the third semester. The kick-off seminar allows the new students to get in touch with each other and their future professors right before the start of the programme. The winter school offers training on soft-skills, such as project and people management, as well as business development. The summer school prepares them for research-based training by working on scientific projects in a team. In addition to the events offered by the programme, they can opt for participation in various events organized by the [Elite Network of Bavaria](#).

1.2 Overview

The ASC programme is designed for outstanding students with Bachelor's degrees in Electrical Engineering, Communications Engineering, Computer Science, or closely related disciplines. The ASC Master's study programme leads them to a M.Sc. degree, which enables programme graduates to work in cutting-edge research. The programme structure complies with internationally recognized Master's programmes and prepares students for subsequent Ph.D. studies. The four-semester curriculum starts in winter. All courses are taught in English and do not require knowledge of the German language.

1.3 Key reasons for choosing ASC

The skills that students acquire in the ASC programme will provide them with in-depth understanding of the digital technologies used to collect, process, prepare, analyse and transfer information, as well as their practical implementation in real systems.

The ASC Elite Master's programme is designed to provide students with an advanced level of technical and scientific training. Digital engineers in Germany will exert a decisive influence on the ongoing rapid pace of technological progress and the high rate of innovation in information and communication technology and its applications, in particular with regard to the emerging fifth generation (5G) communications systems and the Internet of Things.

Intelligent objects (cyber physical systems) will play a central role in the worlds of business and everyday life. Their task will be to log, evaluate and communicate information collected from the environment, in particular multimedia content. If Bavaria's international

competitiveness is to be maintained and extended, major additional endeavours to train the 'brightest minds' are needed; these individuals will subsequently function as 'disseminators' in executive posts in business and science and contribute to advancing the global importance of Bavaria, Germany and Europe.

This Elite Master's programme is characterised in particular by advanced specialist training, intensive individual supervision of outstanding national and international students ('high potentials'), early introduction of students to international cutting-edge research, an international outlook and the core skills it imparts to participants.

These are designed to facilitate life-long learning and the wide-ranging acquisition of new insights in the field.

During the programme, the participants are also made familiar with the specific demands of managerial posts in business and science as the degree programme is supplemented by individual personal development measures and the promotion of leadership and social skills.

The ASC Elite Master's programme makes use of new methods of imparting and acquiring knowledge to achieve its objectives. Participants therefore learn research-orientated working methods very early on and receive personalised supervision. This emphasis on more active involvement of the participants in association with the individualised personal development approach are seen as being core requirements that will prepare programme graduates to assume managerial responsibilities in their subsequent professional careers.

1.4 What makes ASC different?

- A kick-off seminar right before the winter semester. In addition to scientific topics, the one-week winter school offers trainings on soft-skills, such as project and people management and business development. A two-week summer school prepares students for the research-based training by working on scientific projects in a team.
- The study programme includes two or even three research projects, one of them being the six-month Master's thesis. The programme is very flexible. For the major and minor research projects, students can arrange their own schedule by attending related seminars and lectures.
- Publication of research results and participation in conference presentations are strongly encouraged.
- Each student can choose at least one supervising ASC-professor within a special mentoring programme. Mentors provide help in setting up an individualized study programme tailored to the student's interests and career goals.
- ASC-student job: students are guaranteed to get a 'HIWI' job at university to cover at least a part of their cost of living.
- ASC is a programme for only the brightest minds. Highly selective admissions criteria ensure talented students to find an enriching environment among both fellow students and professors.

1.5 The curriculum

The curriculum is a well-balanced mixture of modules in the areas of signal processing, wireless communications, machine learning and artificial intelligence. Mandatory courses in statistical signal processing, information theory, deep learning, and machine learning are complemented with elective and lab courses, individualized research projects, and the Master's thesis.

The mandatory modules convey modern, theoretically-relevant cross-application method knowledge through lectures and practical courses, and promote a very individual and research-orientated specialisation through a targeted project-based approach ('major' research project, Master's thesis). Students are able to design their own personal study schedules with the help of a mentor from the ASC teaching body. Prioritising active involvement of students in an individualised personal development approach is seen as a core requirement that will prepare programme graduates for assuming managerial responsibilities in their subsequent professional careers.

Mandatory modules and practical courses based on modern, fundamental theoretical methods represent a well-founded, interdisciplinary basis for the mastery of a spectrum of key technologies of relevance to our information society now and in the future, whilst the module *Selected Topics in ASC* makes the integration of particularly recent developments in the field possible. During the latter, guest lecturers add to the learning experience while FAU-based members of the ASC degree programme give presentations on their current research. The modules *Mathematical Optimization for Communications & Signal Processing* and *Game Theory with Applications to Information Engineering* taught by professors of mathematics and economics demonstrate the interdisciplinary character of the compulsory curriculum.

Mandatory elective modules and technical elective modules that can be selected on the basis of personal preferences in consultation with the student's mentor make application-specific orientation possible. The curriculum will also feature other courses/lectures given by guest lecturers. The ASC Elite Master's programme assigns particular importance to the elective specialisation modules. As components of *research projects,* they characterise in particular the personalised orientation of the degree programme and allow the outstanding research undertaken by the International AudioLabs and the participating departments to be integrated in the programme.

Practical laboratory experience serves to consolidate the content of lectures. This has to some extent a project-like nature and is intended to promote independent problem-solving skills.

The three events kick-off seminar, winter school and summer school, organised as a single module are a compulsory component of the ASC degree programme. These seminars serve in particular the student's individual personal development, the acquisition of core skills and networking in addition to providing for technical and scientific education.

1) The three-day *kick-off seminar* takes place immediately prior to the lecture period of the first semester outside the university campus on the grounds of the Waischenfeld research campus or the Nuremberg Castle Youth Hostel. It is intended to enable students to get to know one another and teaching staff to engage in exchange, mentors in particular. The programme consists of courses imparting useful soft skills in the areas of self-management, time management, teamwork, presentation techniques and academic writing. Also included is *cultural training* in preparation for working in environments with an international character and time periods spent abroad.

2) A one-week *winter school* is held at the end of the first semester (e.g. at the Waischenfeld research campus). It consists of special courses and lectures in the field of business. A course on *People Management* lasting a number of days is a fixed component.

3) The two-week *summer school* "Ferienakademie" in the Sarntal valley in South Tyrol (Italy) takes place at the end of the second semester. Prior to the summer school, students – working preferably in small groups – develop presentations and reports on programme-related topics that change every year; these are given and discussed in detail in Sarntal and documented in a

conference transcript. Alternatively, students have the option of designing software projects to be implemented during the seminar. Various non-academic events, in particular fireside chats with leading representatives from the world of business, add to the value of the seminar.

The *ASC Forum* is an organisational platform aimed at creating identity and promoting academic exchange within the ASC community through regular events at a central location as well as providing a framework for guest lectures and discussions on topics of relevance to the ASC programme. Active participation in various modules as well as the ASC Forum further enhance the scope of the degree programme in view of the anticipated variety of the student's academic orientations.

The two research projects (RPs) (one mandatory *major* - 15 ECTS credits - and an optional *minor* - 10 ECTS credits) to be undertaken in the third semester are a special and unique feature of the ASC degree programme. They are designed to promote in-depth, independent research in two topics (such as *Audio Processing, Video Coding, Wireless Communications, Molecular Communications, System Design and Implementation, Machine Learning, Game Theory* and *Information Theory)*. If both projects have been selected, they have to be completed at two different institutions of FAU. Having selected the topics in consultation with their respective mentor, students will define the specific design of their project in coordination with the project supervisors. The typical components include: attendance of relevant lectures (especially those listed in the elective module catalogue), internships, seminars, directed reading, evaluation of algorithms, and if wished, design of hardware systems. The participation in the ASC Forum and one presentation on either the *major* or *minor* RP or on the Master's thesis are mandatory. The intention is also to promote cooperation with international research partners, possibly in connection with a period spent abroad. Students are required to prepare a final report in each case. Students are also expected to make a contribution to a congress. The research-based, six-month thesis preparation period should be related to the research being undertaken by the supervisor, and if possible, be integrated in an international joint research project (for instance, collaboration with a guest lecturer) in order to enable a study period abroad.

1.6 Goals of the programme

The aim is to ensure programme graduates have an advanced level of personal development, in-depth knowledge of communication and multimedia technology, are able to employ well-structured academic working methods and have the core skills that will ensure they can be considered as the 'brightest minds' and 'high potentials' who merit appointment to executive posts in business and science.

Thus, they will drive technological progress forward as disseminators in leadership positions with managerial responsibility in business and science and contribute sustainably towards social prosperity.

This will enable society to master the significant challenges it will face in the future, such as the problems associated with the energy supply and an ageing population while also providing a basis for the progress of digitalisation in all areas of life.

One tool that can be employed for this purpose is work on academic projects under the supervision of teaching staff; students are introduced to academic working methods early on in the degree programme. Summer and winter schools and soft skills courses are also employed in order to provide participants with core skills.

Alongside the modules aimed at promoting theoretical knowledge, the curriculum also features modules that focus on the implementation of complex systems to develop skills in

transferring theory into practice. This provides a link between theory and technical implementation and ensures social relevance; this will be of crucial significance to the success and sustainability of the activities of ASC graduates in managerial posts in business and science.

The qualification provided by the ASC Elite Master's programme also represents an outstanding starting point for acquiring a doctorate in the shortest possible time. Furthermore, a doctorate as proof of the ability to undertake academic research independently is often a basic requirement for gaining access to management posts in business and science. It can be expected that the acquisition of wide-ranging academic skills and methods early on in the ASC Elite Master's programme will result in the acquirement of significant academic abilities within the relatively short period of three years that will confirm the course graduates' eligibility as doctoral candidates.

Information for Prospective Students

2.1 Prerequisites

Prospective students should have a solid basis and working knowledge in Engineering Mathematics, Signals and Systems, Communications and Stochastic Signals. Prior knowledge of the German language is not necessary, as all courses will be taught in English. ASC is an Elite Study Course for students with degrees completed far above the average. Minimum grade requirement (Bachelor's degree) for admission is a 2.0[1] in the German grading system.

Bavarian formula:

$$\left(\frac{N_{max} - N_d}{N_{max} - N_{min}}\right) \times 3 + 1$$

N_{max} = highest possible grade in your home country's grading system
N_{min} = lowest possible passing grade in your home country's grading system
N_d = the grade you want to convert (final GPA)

Admission to our graduate programme is very competitive. Simply meeting our minimum requirements is no guarantee of admission.

The ASC programme expects a background in:

- Engineering math: linear algebra, complex analysis, linear differential equations, Fourier transform, Laplace transform, z-transform
- Signals and systems (textbook, e.g., Oppenheim/Willsky: Signals and Systems)
- Communications (textbook, e.g., Haykin: Communication Systems)
- Stochastic signals (textbook, e.g., Pillai/Papoulis: Probability, Random Variables, and Stochastic Processes)
- Minimum knowledge in digital signal processing (Oppenheim/Schafer: Discrete-Time Signal Processing)
- Software: MATLAB or Python

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[1] Note that in the German grading system, smaller numbers mean better marks.

2.2 Application

Deadline: March 15/ July 15

Outstanding graduates are invited to apply for the next winter semester. ASC promotes the professional equality of women and therefore urges women to apply.

The first deadline in March applies to international students who have to apply for a visa.

Applicants should apply via the [Campo Online Application Portal for Master's Degree Programmes of Friedrich-Alexander University Erlangen-Nürnberg](#) and upload the following documents as scanned copies:

- Curriculum vitae (CV) including a passport picture (necessary for identification in online interviews)
- ASC [application form](#)
- Secondary school's leaving certificate (certified English or German version)
- Bachelor's degree and academic transcripts (English or German version)
- TOEFL score report (minimum score IBT 80, PBT 552, CBT 216) or other proof of English-language education (IELTS 5.5, level B2 of the Common European Framework of Reference for Languages, Medium of Instruction Certificate, etc.)
- APS certificate (for applicants from India, China, Vietnam)
- GRE test results (if any)
- certificates for German language courses or tests (optional)
- recommendation letters of two of your academic teachers that know you well (optional)

Before submitting your application documents or sending requests please read the application instructions carefully.

There is no application fee. German language knowledge is not required.

Selected applicants will be invited for personal or video interview. The interview takes approximately 30 minutes and serves to assess the background for a successful completion of the ASC programme.

After the screening process, you will be informed whether you have been selected for admission to the ASC programme.

2.3 Admission and enrolment to the programme

Students have to observe the instructions given on the online application portal [Campo](#).

Students who have not received their Bachelor Degree yet, should submit their latest transcript of records and a certificate of their university with the date of their foreseeable graduation. The Master's Office will then carry out the formal application procedure. Students have one year to submit their bachelor's degree certificate.

Before their arrival in Germany, students have to enroll by sending their documents by mail to the Student Record Office (Studentenkanzlei, Halbmondstraße 6-8, Erlangen). For this, they need the following documents:

- Signed Enrolment form ("Onlineantrag auf Einschreibung"; available in campo.fau.de) (scanned copy)
- School certificate of qualification for university entrance – (certified copy). If the original certificate was not issued in German, English, or French, a certified translation is required.
- Your latest diploma/Bachelor Degree Certificate – (certified copy). If the original certificate was not issued in German, English, or French, a certified translation is required.
- Electronic confirmation of health insurance (known as M10). Apply for it at your health insurance provider quoting FAU´s reference number (H0001887). The health insurance company will then send a digital copy directly to FAU.
- Confirmation of semester fee payment (e.g. bank transfer confirmation, bank statement. The following data should be visible: account holder, IBAN, BIC, date of bank transfer, payment reference, and amount paid. All other data can be redacted.)
- Passport – (copy of passport)
- Admissions letter from FAU (scanned copy)

2.4 Re-Registration (Rückmelden)

The re-registration serves as a confirmation for the enrolment to the next semester. The re-registration does not require appearing at the Student Record Office, but is effectuated by bank transfer of the student services contribution (67 €). All students receive a remittance slip together with their semester documents.
Students have to observe the respective dates (typically the first week of February for summer semesters, and the first week of July for winter semesters). The fee must be paid by bank transfer within the deadlines for re-registration at the University, as otherwise you risk being de-registered.

2.5 Orientation courses

This website shows the orientation courses for international students that are offered by the Central Office for International Affairs in cooperation with FAU's faculties and institutions.
The Central Office for International Affairs offers welcome weeks for international students at the beginning of each semester (September/October) to help you with legal formalities as well as the general onboarding at FAU.

2.7 Scholarships

The University Erlangen does not offer own scholarships. Each student may however apply for a scholarship offered by various organizations (foundations, companies, political parties, religious groups, etc.). The scholarships are not always awarded based on performance in previous studies alone. The German Academical Exchange Service (DAAD) offers an extensive compilation of different possible funds.

Furthermore, the FAU has also compiled a [list of foundations](#) offering a variety of scholarships.

2.8 Student jobs

Students are allowed to work inside and outside the university while being enrolled. As the ASC curriculum is designed for full-time students, the extra workload for money-making should be restricted. The various institutes and research labs of the university also offer student jobs. They usually allow for a convenient timing in compliance with courses and without extra commuting time. The bulletin boards and websites of the respective chairs should be checked for this.

Many students work alongside their studies in Germany. International students are also entitled to seek employment. However, the regulations that apply here are different for international students. Please go to this FAU website for more information on extra income and work experience: https://www.fau.eu/education/international/from-abroad/important-information/employment-and-placements/. EU and EEC citizens have unrestricted working times, but of course should keep their studies-work balance in mind.

ASC students have a guarantee to work (for 9h/week, approx. 460 €/month) as research assistants during their first year of studies, which is a great way of gaining hands-on research experience while getting paid. A wide range of jobs are offered, including preparing lecture materials, assistance in lab course, implementation of algorithms and many more. Students can contact professors or Ph.D. students for further information.

Students are encouraged to utilize synergies between their student jobs and their research projects when possible. Doing so, students can expand their horizon by working on new subjects, possibly related to one's area of interest, and have a better and deeper understanding on the topics learned before.
Furthermore, students might need to rely on literature as the starting point of their own project, hence honing their literature review skill, which is a critical part of the Master's thesis and the Ph.D. work. Lastly, the opportunity provides an important financial support so that students can afford their living expenses.

2.9 Mentoring programme

ASC has an outstanding mentoring programme. With the help of a mentoring professor in their interested field of study, students improve their understanding of the career paths and resources available to them, as well as receive résumé and career advice from professionals within their desired professions. Throughout the duration of study, the mentoring professors will work closely with their students, providing academic guidelines and career path suggestions. In addition, the mentoring professors assist their students with the preparation of their study plans and their future careers. Closely interacting with individual students, the mentoring professor provides advice tailored to the needs and interests of each individual student.
Intensive and personalised supervision is crucial for the success of high-potential students and this is therefore an intrinsic part of the degree programme. The mentor is assigned as a contact partner to each ASC student for the entire duration of the degree programme to ensure the

greatest possible quality of education and training. Mentoring involves, in addition to the monitoring of individual progress throughout the degree programme, a number of personal counselling interviews per semester as well as personal advice with regard to the choice of compulsory optional courses and elective courses, on the topics of *research projects* and that of the *Master's thesis*. Mentors also provide advice on how these should be organised, and provide support in additional areas, particularly with regard to the proposed research stay at a partner institute abroad. Furthermore, students are advised to collaborate closely with research associates during their various projects and can be offered a post as a student assistant with one of the participating professorships.

Chapter 3

General Programme Structure

3.1 Overall structure of the programme

The Master's study programme is offered completely in English language. With a total duration of four semesters, it foresees three semesters of lectures that consist of mandatory courses, mandatory elective courses, elective courses, and the projects. The mandatory elective courses also include two lab courses. The last semester is mainly dedicated to the preparation of the Master's thesis. Generally, admission to the Master's programme requires at least an above-average Bachelor degree and is granted on a competitive basis.

3.2 European Credit Point System ECTS

According to the European Credit Transfer System (ECTS) each course is assigned a number of points, so-called ECTS-points, which represent the expected associated workload in full hours, where 1 ECTS credit point corresponds to 30 hours (60 min per hour) per semester.

3.3 Grading system

The grading system is regulated in §18 of the General Examination Regulations of the Faculty of Engineering

1.0 1.3	excellent	an excellent achievement	passed
1.7 2.0 2.3	above average	an achievement that meets the requirements distinctly above average	
2.7 3.0 3.3	average	an achievement that complies with the requirements	
3.7 4.0	adequate	an achievement that, despite of occurring shortcomings, still complies with the requirements	
4.3 4.7 5.0	not adequate	an achievement that, because of significant shortcomings, does not meet the requirements	not passed

The final cumulative grade for the Master's Examination is the arithmetic average over all graded modules weighted by the respective number of ECTS credit points and allows only one decimal place.

Cumulative Grade	Cumulative Grading
≤1.5	excellent
1.6 … 2.5	above average
2.6 … 3.5	average
3.6 … 4.0	adequate

Whoever completes the Master's Examination with a cumulative grade of 1.2 or better obtains the distinction

„graduated with distinction".

3.4 Modularity of lectures

The Master's programme comprises a set of modules. To each module, an ECTS value is assigned, which should describe the associated workload for an average student including attendance of lectures and preparation for examinations (1 ECTS point corresponds to 30 hours). A module constitutes a consistent and temporally coherent study unit that is usually (but not necessarily) concluded with an examination. Examinations are "studienbegleitend", which means that the written or oral examination takes place during the exam periods. A module usually consists of a lecture (Vorlesung) and a supplemental class or tutorial (Übung). Some modules might also contain a lab course (Praktikum). A lecture and the accompanying supplemental course or a tutorial belong together and cannot be credited as separate classes. Typically, the lecture is given by a faculty member, while the supplemental course or tutorial is taught by a teaching assistant. Students are strongly advised to actively participate in the supplements. The supplements are often accompanied by assignments. For each module, there are one or more faculty members that are responsible for that module.

The module content and examination modality, i.e., whether the examination is performed in written or oral form and the duration of the examination, are specified in detail in the module description (Modulbeschreibung). Generally, the responsible faculty member or instructor for each module announces the requirements for successful completion of the module, and it is each student's responsibility to inform herself/himself about these requirements.

More information about exams can be found within the [General Examination Regulations for the Bachelor's and Master's Degree Programmes at the Faculty of Engineering](#).

3.5 Curriculum

Table I (for batch 21/22 and later)

Module			ECTS per Semester			
Type	Name (in alphabetical order) or Class	Number	1st	2nd	3rd	4th
Mandatory modules (50 ECTS)	Deep Learning	48455		5		
	Game theory with Applications to Information Engineering	48432		2,5		
	Information Theory and Coding	48410	5			
	Kick-Off Seminar, Winter and Summer School	48460	2,5	2,5		
	Machine Learning in Signal Processing	48440	5			
	Mathematical Optimization in Communications and Signal Processing	48400	5			
	Research Project (Major)	48470			15	
	Selected Topics in ASC	48451		2,5		
	Statistical Signal Processing	48420	5			
Mandatory-Elective Modules (20 ECTS)	From "**Technical Mandatory-Elective Courses**" (Table II)	1700		15		
	From "**Technical Lab Courses**" (Table II)	1750	2.5		2.5	
Elective Modules (20 ECTS)	From "**Nontechnical Elective Courses**" (Table II)	1500	5			
	From "**Technical Elective Courses**" (Table II)	1800			15	
Master's Thesis (30 ECTS)	Master Thesis	1999				30
Sum ECTS per Semester			**30**	**27,5**	**32,5**	**30**
					Sum ECTS in total: 120	

Table II

Module			ECTS in Winter Semester	ECTS in Summer Semester
Class	Name (in alphabetical order)	Number		
Technical Mandatory-Elective Courses (binding list, NOT extendible)	Advanced Communication Networks	151664		5
	Advanced Topics in Deep Learning	42800		5
	Channel Coding on Graphs	412023		5
	Communications Systems Design	700506	5	
	Convex Optimization in Communications and Signal Processing	96850	5	
	Embedded systems	44410	5	
	Human Computer Interaction	645618		5
	Image and Video Compression	96310		5
	Introduction to Deep Learning	43405	5	5
	Introduction to modern cryptography	93015	7,5	

	MIMO Communication Systems	96300		5
	Mobile Communications	43141		5
	Quality of Service of Communication Systems	44362		5
	Radar, RFID and Wireless Sensor Systems (RWS)	96316		5
	Research Project (Minor)	48480	10	10
	Speech and audio signal processing	96460		5
Technical Lab Courses (extendible list)	Audio Processing Laboratory	894349	2,5	2,5
	Communications systems design	92355	2,5	
	Digital communications lab	293179	2,5	2,5
	Lab course image and video processing on embedded platforms	194239	2,5	
	Lab course machine learning in signal processing	878210	2,5	2,5
	Laboratory course: Mobile communication	97640		2,5
	Image and video signal processing on embedded platforms	97525	2,5	
	Image and Video Compression	97651		2,5
	Lab Course Statistical Signal Processing		2,5	
	Lab Course Communications Systems Design	92356	2,5	
Technical Elective Courses (extendible list)	Advanced Networking LEx	869547	5	
	Advanced Optical Communication Systems	621649	5	
	Advanced Topics in Deep Learning	42800		5
	AI-enabled Wireless Networks	93172	5	
	Approximate Computing	965820		5
	Architectures for digital signal processing	96010	5	
	Audio Processing for the Internet of Things	44522		2,5
	Body area communications	816185	2,5	
	Channel coding	96270	5	5
	Cognitive Neuroscience for AI Developers	44445	5	5
	Communications systems design	92355	2,5	
	Compressive Sensing	48447		5
	Computer vision	713618		5
	Convex Optimization in Communications and Signal Processing	96850	5	
	Cryptocurrencies	566245		
	Diagnostic Medical Image Processing	44150	5	5
	Equalisation and adaptive systems for digital communications	43400	2,5	
	Introduction to Deep Learning	43405	5	5
	Linear and non-linear fibre optics	267499		5
	Machine learning for time series	428256	5	
	Machine learning in communications	668129	5	
	Molecular communications	454183	5	
	Multiuser information and communications theory	687141	5	
	Pattern analysis	44120		5
	Pattern recognition	44130	5	
	Radar, RFID and Wireless Sensor Systems (RWS)	96316		5
	Radar signal processing	44400	5	
	Random matrices in communications and signal processing	451971	5	
	Reconfigurable computing (lecture with exercises)	741941	5	
	Reconfigurable computing (lecture with extended exercises)	714289	7,5	
	Reinforcement Learning	93185		5

	Self-Organized Networks	43960		5
	Signal analysis	250058	2,5	
	Speech enhancement	96880	2,5	
	Transforms in signal processing	498723		2,5
	Transmission and detection for advanced mobile communications	43420		2,5
	Virtual vision	96314		2,5
Nontechnical Elective Courses (extendible list)	Choose any course from the "Electives, soft skills and language courses" section on Campo (Home – Studies offered – Show university course catalogue)			
	German Language courses (for international students)			

Please note: The examination achievements in the Mandatory Modules (exception: major project) can be repeated twice; the examination achievements in all other modules can only be repeated once.

3.6 Study Plan

No later than two weeks after the start of lectures each semester, students must submit a study plan for the current semester, approved by the mentor, to the ASC office.
The study plan documents the course of studies planned for the current semester as well as, if applicable, the study progress and success of previous semesters.
'Research Projects' and Master's thesis have to be documented in the curriculum in such a way that an assessment of the thematic diversity according to § 43(3) can be made on the basis of the summary of the topic and the indication of the supervisors.
Please note that this concept is a binding version and later alterations require the consent of the Admission Committee.

Filled sample of an ASC-Study Plan:

**Advanced Signal Processing &
Communications Engineering (ASC)**

Please use correct
version! (Semester
start of your studies)

1

**Version
Batch WS
21/22**

**Study Plan for the Elite Master's Degree Programme
Advanced Signal Processing & Communications Engineering (ASC)**

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current number of semesters of
study with ASC

Current Semester	Semester Start of Studies	# Sem	Matriculation Number
WS 2022/23	WS 2021/22	3	123 345 789

Bachelor Degree

Last Name	First Name		Graduated from
Mustermann	Max Moritz		University of Wherever

Signatures

Date: 31. September 2021

Date: 31. September 2021

Signature: _____

Signature: _____

Full
Name: Max Mustermann

Full
Name: Prof. Wolfgang Müller

Function: STUDENT

Function: MENTOR

Study Plan for the Elite Master's Degree Programme Advanced Signal Processing & Communications Engineering (ASC)   *Version Batch WS 21/22*

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Study Plan

Course Plan

Type of Module	Standard Semester Sem-x (WS/SS)	Module Name	ECTS	Planned Semester Sem-x (WS/SS)	Course Passed MM-YYYY
Mandatory Modules (50 ECTS)	Sem-1 (WS)	Mathematical Optimization for Communications and Signal Processing	5	WS 2021/22	02-2022
	Sem-1 (WS)	Information Theory and Coding	5	WS 2021/22	02-2022
	Sem-1 (WS)	Statistical Signal Processing	5	WS 2021/22	02-2022
	Sem-1 (WS)	Machine Learning in Signal Processing	5	WS 2021/22	02-2022
	Sem-2 (SS)	Deep Learning	5	SS 2022	09-2022
	Sem-2 (SS)	Game Theory with Applications to Information Engineering	2.5	SS 2022	*
	Sem-2 (SS)	Selected Topics in ASC	2.5	SS 2022	09-2022
	Sem-1 (WS) Sem-2 (SS)	Kick-off Seminar, Winter School & Summer School	5	WS 2021/22 SS 2022	10-2022
binding list, see Table II	Sem-3 (SS)	Research Project (Major)	15	WS 2022/23	
Technical Mandatory-Elective Courses (15 ECTS)	Sem-3 (SS)	Research Project (Minor)	10	WS 2022/23	
	Sem-3 (SS)	Mobile Communications	5	WS 2022/23	**
Technical Lab Courses (5 ECTS)	Sem-1 (WS)	MLISP Lab	2,5	WS 2021/22	01-2022
	Sem-2 (SS)	Mobile Communications Lab	2,5	SS 2022	09-2022
Nontechnical Elective Courses (5 ECTS)	Sem-2 (SS)	German A2.1	5	SS 2022	09-2022
Technical Elective Courses (15 ECTS)	Sem-2 (SS)	4G/5G Communications	2,5	SS 2022	10-2022
	Sem-3 (WS)	Molecular Communications	5	WS 2022/23	**
	Sem-3 (WS)	Machine Learning in Communications	5	WS 2022/23	**
	Sem-4 (SS)	Transmission and Detection for Advanced Mobile Communications	2,5	SS 2023	
Master's Thesis	Sem-4 (SS)		30	SS 2023	

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Study Plan

Research Project(s)

Supervisor = supervising professor NOT their research assistant

broad topic sufficient, final title required in Project Form

Module	Supervisor and Topic *
Research Project (Minor) - optional (ECTS towards Technical Mandatory-Elective Courses)	Supervisor: Prof. A. Schmidt Topic: "Power Allocation for Multi-Antenna Transmitters in Heterogeneous Networks"
Research Project (Major) (ECTS towards Mandatory Modules)	Supervisor: Prof. W. Müller Topic: "Machine Learning for Sequence Estimation in Molecular Communications"

* Use this table to state your plans at the beginning of the 3rd semester at the latest. Fill in the additional "Project Form" with the final title and other details to state your final plans BEFORE you actually start your project work

Study Plan Comments

* Exam will be retaken

** Exams will be delayed because of Erasmus Exchange Semester

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3.7 Research Projects

The study programme includes two or three research projects: one or two student projects (major and optional minor) with different size and scope and the six-month Master's thesis.

The programme is very flexible. For the major and optional minor research projects, students can arrange their own schedule by attending related seminars and lectures. If students include lectures or seminars to their project, they should not take the exam of the lecture. This is because it is not allowed to earn ECTS points for taking the exam and to include the same lecture in a project.

If both, the minor and major project are selected, they have to be completed at two different institutions. At least one project has to be presented at the ASC Forum.

The projects are intended to develop the students' skills for carrying out their own scientific research after graduation. There are a wide range of topics for students to choose from: audio processing, video coding, wireless communications, molecular communication, system design and implementation, machine learning, game theory, information theory, communication networks, or embedded systems.

Students can get various opportunities for international research cooperation from the mentoring professor, potentially leading to staying abroad. To determine a topic, students are required to consult with their mentors first.

The projects bridge the gap between theoretical foundations and technical implementations. Students will have the opportunity to put theory into practice, and have hands-on experience on real-world applications. More advanced lectures and one-on-one directed reading courses deepen the students' knowledge.

Upon graduation, programme graduates will be equipped with extensive research experiences and skills, and well prepared for subsequent doctoral studies or the job market.

3.7 Master's thesis

The Master's thesis should be completed during the fourth semester. It should provide a stimulating educational experience for the student emphasizing creativity, self-organized scientific work and studying, a training in research methodology and scholarly writing and presentation. The thesis project lasts exactly six months starting from the registration at the examination office by the supervisor and with a workload of 30 ECTS. In the end, the thesis is handed in to the examination office as a written document with typically 50 – 100 pages. Suggested topics are announced at the bulletin boards of the respective chairs or can be arranged with the supervisor directly. The presentation generally lasts 50 minutes, and the supervisor arranges the specific date.

Students have to complete at least 75 ECTS before they are allowed to start their Master's thesis.

3.8 German language courses

Although you can study our Master's programme completely in English, your German skills will oftentimes be the decisive factor when it comes to getting a job or an internship at a company in Germany. Moreover, it will facilitate your daily life tremendously if you can speak to your landlord or a shop vendor in German. Your German classmates are also easier to approach if you know some basics about their language and culture.

As part of the ASC curriculum, the 'non-technical elective' may include German language courses. The FAU SprachenZentrum offers German courses for students of all disciplines in Erlangen and Nürnberg. If you want to attend a course, you first need to have your ability in German assessed. For more information please go to: [FAU SprachenZentrum - German courses](#).

3.9 Winter and Summer School

Winter School

ASC students will participate in a one-week winter school held at the end of the first semester, with lectures that focus on industrial and professional experience. While scientific knowledge is one thing, social ability is also important to one's career. The main focus of the winter school is people and project management.

Summer School

ASC students are required to participate in a two-week summer school jointly operated by TUM, Uni Stuttgart and FAU. The "[Ferienakademie](#)" takes place after the second semester in the Sarntal valley in South Tyrol (Italy), in which students from the three universities and various disciplines gather to work on timely projects.

Students work in small groups on dedicated scientific topics that change from year to year. During the summer school, students will give presentations, submit reports, discuss their results in depth with both fellow students and supervisors, and compile proceedings. Alternatively, students can also design software projects, which they will implement in this two-week period. Aside from scientific projects, the summer school is accompanied by many social activities, including hiking and campfire talks with industry leaders. Throughout this two-week summer school, ASC students have practical hands-on experience while having fun with their peers.

ASC students have to apply in good time for the summer school. Please go to the website for dates and more information https://ferienakademie.de/en/home-2/.

3.10 Registration for examinations

Students have to register themselves for examinations via the internet platform Campo. The ASC coordinator holds a meeting for the freshmen to familiarize them with the system as part of the ASC Kick-off seminar. It is vital that students are aware of the time windows in which they are able to register for exams. Generally, for the winter semester, the window is in mid-November, and in the summer, it is early April. Students are able to withdraw from their registration without giving any reason on Campo. If they have failed an examination, they will be automatically registered for the next examination that they then have to complete. The re-examination can be cancelled only because of evidenced health reasons. Therefore, students have to consider the instructions on the next page.

3.11 Repetition of examinations

A student who failed an examination can repeat the mandatory module examinations twice (exception: major project). All other examinations can be repeated only once. The re-examination has to be taken at the next available date, normally within six months after the result of the first exam has been communicated. The student is automatically registered for the next available date. If a student should miss this date, they fail the examination.

Please also read the general FAU regulations on taking examinations, withdrawal and illness.

3.12 Examination deadlines

Students are expected to pass the examinations in due time so that they obtain the required 120 ECTS credits within the intended study period of four semesters. The required ECTS credits have to be obtained within five semesters at the latest.

3.13 Compensation for disadvantages due to chronic illness and disability

Students with disabilities or chronic illnesses can apply for compensation for disadvantages in examinations (e.g. longer processing time, approval of aids). This applies to all physical and mental impairments that last at least 6 months, as well as to illnesses that require at least one medical treatment per quarter over the course of a year. A certificate of severe disability is not required for disadvantage compensation. Furthermore, the disadvantage compensation does not appear in the certificate documents. If students are interested in applying for a disadvantage compensation, they can find further information at the following link: https://www.fau.eu/education/advice-and-services/support-services/students-with-disabilities/

INFORMATION SHEET

Examination participants, who have to discontinue the examination due to health reasons, should observe the following procedure:

1. They are asked to go to one of the university hospitals (depending on the kind of their illness) immediately. Addresses are listed in Chapter 6.
2. They should submit this leaflet at the university hospital without further notice.
3. In the medical certificate of the university hospital must be mentioned if there is a disability to do the exam and whether this occurred before or during the exam.
4. Please ask for acceptance of the exam cancellation. The medical certificate can be handed later.
5. Afterwards the medical certificate has to be forwarded to the Examination Office.

Note of the exam supervisor

Name of the exam participant: _____

Date of the exam: _____

Start of the exam: _____

Discontinuing of the exam: _____

_____

Name and signature of the examiner or supervisor

Chapter 4

Studying in Erlangen

4.1 Erlangen and its surrounding area

The University of Erlangen-Nürnberg was founded in 1743 and currently has around 40,000 students. The Faculty of Engineering (Technische Fakultät) with about 10,500 students is located in Erlangen, a city with a historic baroque centre, which is located amongst splendid landscape close to the rocky hills and lovely forests of the Fränkische Schweiz. The cities of Nuremberg (a traditional center of arts and commerce since medieval times) and Bamberg (an UNESCO world heritage town) lie about 20 km to the south and 40 km to the north, respectively. Bayreuth is about 80 km away, while Munich, Frankfurt and Stuttgart, the other large cities of southern Germany, can all be reached within about 2 hours journey by train or car. One of Erlangen's best known and most loved attractions is the "Bergkirchweih", a beer festival in spring, which attracts around 1 million visitors from near and far.

For more information about student life, are and culture, sports and leisure check https://www.fau.eu/education/student-life/erlangen-nuremberg-region/

4.2 Research and industry

In the wider world, Erlangen is also renowned both as home to the second largest university in Bavaria and as one of the three headquarters of Siemens AG, which both contribute substantially to the high living standard in and around the city. With its broad range of additional privately and publicly funded research facilities and many start-up high-tech companies, Erlangen and its surroundings have developed into an important European R&D centre in several future-oriented areas of engineering, including core ASC areas, such as medical systems, microelectronics, audio (Fraunhofer IIS, Dolby), multimedia and communications (e.g., Intel, Nokia).

4.3 Site plan of the main campus of the Faculty of Engineering
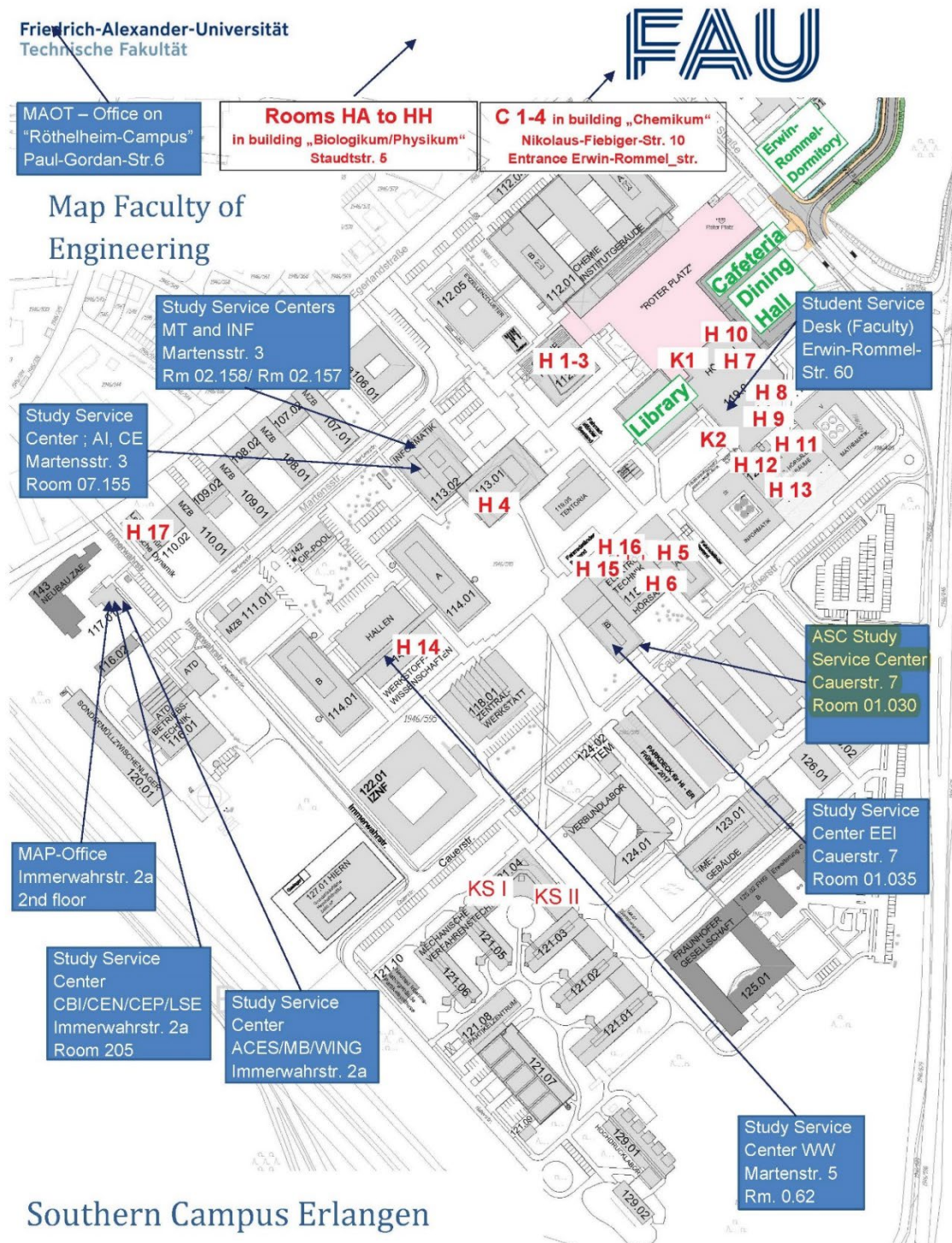
Important Internet Platforms at FAU

5.1 IdM (= Identity Management)

The idM-Portal is where you log in first after enrollment. For this, you will need the activation code you have received from the Student Records Office after submitting all enrollment documents and paying the semester fee. You will receive your personal user identification and password via post after paying the fee (if you indicate a correct address!). You will also find this letter in the Campo portal in the "Student Services" section.

With this user identification, you activate your IdM account and must upload a photo of yourself for your student card (FAUcard), which you can use for paying in the cafeteria or using the library services, for instance. After completing this step, you will receive your FAUcard within the following four weeks (if you already reside in Germany; if not, you can pick it up after your arrival).

The IdM-Portal contains your general user data. For example, you can check for which services your card is activated under the category "Services". The button "Requests/Tasks" allows you to block your FAUcard if you happen to lose it. The email forwarding function allows you to redirect the emails you receive at your @fau address to another email address (Home » Profile » Data overview: relaying to a different email address). If you do not use your FAU email account regularly, please use the relaying service in order not to miss important information! Another one of your first steps in the IdM-Portal should be to activate the library services of your card by clicking on "Requests/Tasks", "FAUcard","Library account activation" and follow the steps. The activation of your library account may take one to two working days. On the first page of the IdM-Portal, you can subscribe to newsletters or cancel a subscription.

5.2 UnivIS (= University Information System)

Since the old university information system (http://www.univis.fau.de/) has been replaced by the Campo portal in winter semester 22/23, you will only use UnivIS for looking up people and rooms/lecture halls. If you want to know where the office of your study advisor or your lecturer is located or under which telephone number you can reach your contact person at the Examinations Office, you can enter the person's last name in the "people" search in UnivIS and get access to their contact details. If you need the GPS data of a lecture hall to locate it on campus you can use the "rooms" search function.

5.3 StudOn

StudOn is the communication and learning platform for all FAU students. You have your personal desktop, where you can manage the classes and groups for which you are registered. In these groups, you have the possibility to communicate with the lecturers and tutors, as well as with other students. Furthermore, you can find the material (lecture slides, tutorial exercises) for the corresponding lectures and tutorials. The link to the corresponding StudOn course is embedded in the lecture details in Campo.

5.4 [Campo](#)

The Campo portal is used for the master application and administrating the enrollment at FAU. At the beginning of your studies, after receiving your admission letter, you generate your enrollment form in the Campo portal, print and sign it and send it to the Student Records Office (together with the other required enrollment documents).

During your studies, you use Campo to inform yourself about the courses and modules that are offered for your study program. You can access the whole course catalog for the current semester by clicking on the three bars in the top left corner of the Campo starting page and then on "Studies offered", "Show university course catalog", the "Faculty of Engineering" and your study program. The puzzle piece symbol represents the modules, which may consist of different courses (e.g., lecture and exercise). If you click on the book symbol you access the course itself. By clicking on "parallel groups/dates" you can see the time of the course, the room where it takes place and the name of your lecturer. In the top left corner, you can add the course to your personal course schedule ("save to schedule"). You will now be able to find the saved course under "Home" – "My studies" – "schedule". If you cannot find a book symbol under the puzzle piece symbol, this means that the course is not offered in the current semester (but probably in the next semester). The medal symbol stands for the exam for the respective module, which generally takes place every semester, regardless of whether the course is offered or not.

In order to access the content of each module (i.e., learning objectives, recommended literature etc.) please have a look at the pdf module handbook that is available on your study program website.

You also use Campo to register for your exams (about 4 weeks after the start of the lecture period) and you will see your overview of exams and grades there later on.

Moreover, you can download your enrollment certificate and your current transcript of records in the section "Student Services".

5.5 [OPACplus](#)

OPACplus is the Library Catalogue of FAU. It contains media stock of the main library and their branches. Students obtain access to different research magazines online. OPACplus also offers inter-library borrowing from libraries all over Germany. Foreign students are able to book guided library tours in English language (for more information please go to https://ub.fau.de/en/studying/advice-and-training/library-courses/).

5.6 VPN Client

The VPN Client (Virtual Private Network) offers you the possibility to access the university's network and its services from your home. In most cases, it is sufficient to install the Cisco VPN of FAU's Computer Center, which can be downloaded for different operating systems at the Computer Center's website (in German): **www.rrze.fau.de/dienste/internet-zugang/vpn/**

By using this method, you can access software provided by the Computer Center to enrolled students, and you can also use the wide range of e-books and online publications offered by the university library.

5.7 Overview: which tool is used for what

Online-Tool:	Functions:
Idm-Portal	General user information
	FAUcard
	Blocking FAUcard if lost
	Redirecting FAUmail account to other email account
	Activating key card function of FAUcard for computer science building
	Subscribe to/unsubscribe from FAU newsletters
UnivIS	Search for people
	Search for rooms
	Courses and modules before WS22/23
StudOn	Platform for communication and e-learning
	Course materials
	Forums for individual courses
Campo	Application for studies
	Requesting enrollment
	Courses and modules from WS 22/23 and onwards
	Creating course schedule
	Exam dates
	Registration for/Deregistration from exams
	Certificate for immigrations office (confirmation of study success)
	Enrollment certificate
	Overview of grades/transcript of records
	Information on re-registration process

Chapter 6

Contact Persons and Addresses

ASC Chairman
Prof. Dr.-Ing. Ralf Müller
Raum 05.036
Cauerstraße 7, 91058 Erlangen
ralf.r.Mueller@fau.de

ASC Coordination
Lena Borke-Weber
Room 01.030
Cauerstraße 7, 91058 Erlangen
lena.borke-weber@fau.de

ASC Office
Martina Luber
Room 01.030
Cauerstraße 7, 91058 Erlangen
martina.luber@fau.de

asc-admission@fau.de
(joint E-Mail ASC-Team)

FAU Examinations Office (Faculty of Engineering)
Andrea Wilfert (Officer for ASC)
Tel: +49 (9131)/85-26707
E-Mail: andrea.wilfert@fau.de

FAU Student Records Office
Halbmondstraße 6-8, 91054 Erlangen
Tel: +49 (9131)/85-71224
studentenkanzlei@fau.de
https://www.fau.eu/education/advice-and-services/student-records-office/

FAU Central Office for International Affairs (RIA)
Helmstraße 1, 91054 Erlangen
welcome-students@fau.de
https://www.fau.eu/education/advice-and-services/contacts-central-office-forinternational-affairs/

FAU International Office of the Faculty of Engineering
Erwin-Rommel-Straße 60, 91058 Erlangen
https://www.tf.fau.eu/studying/international/contact-list/Christine Mohr
Room U1.250
Tel: +49 (9131)/85-27851
E-Mail: christine.mohr@fau.de

FAU Student Advice and Career Service (IBZ), City Center
Halbmondstraße 6-8, Room 0.021
Tel: +49 (9131) / 85-24444 or 85-23333
https://www.fau.eu/education/advice-and-services/student-advice/
Office hours: Mon - Fri: 8 a.m. - 2 p.m.

General Study Advisor (Faculty of Engineering):
Elisabeth Grosso
Room 1.031
Tel: +49 (9131)/85-24809
Email: elisabeth.baechle-grosso@fau.de

FAU Psychological-psychotherapeutic Counseling Center - Faculty of Engineering
Dipl.-Psychologin Elizabeth Provan-Klotz
Dr. Dominik Özbe-Schönfeld
Rooms U1.251 and U1.252
Erwin-Rommel-Str. 60, 91058 Erlangen
Email: tf-psychologische-beratungsstelle@fau.de
https://www.tf.fau.eu/studying/advice-and-services/psychological-services/

FAU Computer Center - Service Desk
Martensstraße 1, 91058 Erlangen
Room 1.013, Mon - Thu: 9 a.m. - 4 p.m. ; Fri: 9 a.m. - 2 p.m.
Tel: +49 (9131)/85- 29955
E-Mail: rrze-zentrale@fau.de
www.rrze.fau.de/ (in German)

Campo Support:
E-Mail: campo@fau.de

FAUcard Service Office
https://www.fau.eu/study/programme-start/faucard

FAU Language Centre (SZ)
www.sz.uni-erlangen.de/

Mensa/Cafeteria (meal plan)
https://www.werkswelt.de/index.php?id=php&id=mensen-cafeterien-Cafebars

University sports
https://www.hochschulsport.fau.de/

Emergency phone numbers and University hospital departments

In case of life-threatening emergencies

Rescue Coordination Centre (call in Europe)	112
Poison Control Centre Nuremberg	+49 89 19240

For urgent but non-life-threatening emergencies

Patient Service with 24/7 medical on-call service in German language For more information click here	116 117

Accident and emergency units at Universitätsklinikum Erlangen

http://www.uk-erlangen.de/en/emergencies/
(including Map of Erlangen with Directions to all Emergency Units)

Midwifery / Delivery Room Universitätsstr. 23 a	09131 85 - **34900**
Accident and Emergency Unit for internal medicine (including Chest Pain Unit and Department of Dermatology) Ulmenweg 18, for cars via Krankenhausstr.	09131 85 - **35420**
Accident and Emergency Unit for Paediatrics and Adolescent Medicine Loschgestr. 15	09131 85 - **33118** **or 33119**
Accident and Emergency Unit concerning head injuries (including Stroke Unit and mental emergencies) Schwabachanlage 6	09131 85 - **34338**
Accident and Emergency Unit for Surgery Entrance Maximiliansplatz	09131 85 - **33260**