

Space Technology

# International Summer School

4 – 15 September 2017 in Würzburg, Germany  
for Advanced Students

Julius-Maximilians-

**UNIVERSITÄT  
WÜRZBURG**



Dieses Vorhaben wird aus Mitteln des Bundesministeriums für Bildung und Forschung unter dem Förderkennzeichen 01PL16019 gefördert.

**DAAD**

Deutscher Akademischer Austausch Dienst  
German Academic Exchange Service



## Information Brochure

The department of computer science, the chair of Aerospace Information Technology and the Chair of Computer Science VII of the University of Würzburg are pleased to announce that the summer school of Space Technology will be offered this summer.

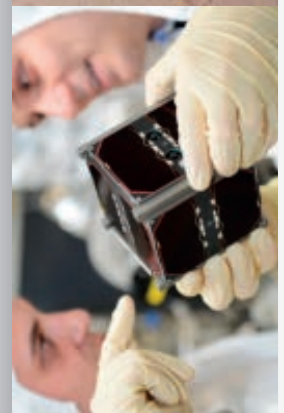
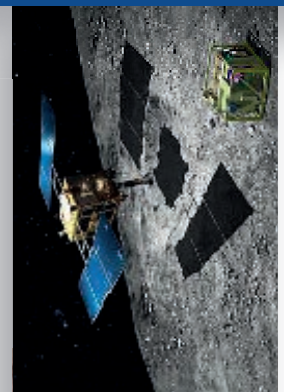
The summer school is primarily directed at students of computer science and aerospace technology or related study paths. We address advanced students, Master's degree and PhD-students but very good bachelor's students may apply as well.

The summer school is directed at students from Latin America and Eastern Europe in particular. If you are from one of the following countries you can apply for a scholarship: Guatemala, Poland and the Czech Republic. For further details see the section "Application".

This summer school is designed for students studying subjects related to information and aerospace technology. While at German universities typically aerospace technology is taught from a mechanical engineering perspective you can learn about this subject at the University of Würzburg from the mathematics and computer science perspective.

## Course Description

The participants will learn about spacecraft design, the related hardware and software and much more. The lectures will include an introduction to spacecraft system design, history of space flight, space environment, space dynamics, thermal control of satellites, telecommunications, structure and mechanics, on board data handling, space craft operations, power systems and more. The course offers lectures and practical exercises.





## Course Subjects

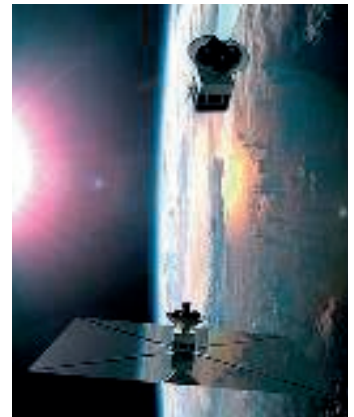
**Spacecraft System Design** The Spacecraft System Design (SSD) lecture gives an extensive introduction to state of the art system design aspects of satellites and launch vehicles. The lecture starts with basics of orbital mechanics and handles important issues of space mission design and mission analysis, like contact times or shadow periods.

**Information Technology and Devices in Satellites:** Satellites always consist of a typical set of subsystems. These are e.g. reaction wheels for attitude control, solar cells and batteries that ensure continuous operation and much more. With respect to dimensioning and interconnecting such subsystems there are classic and future-oriented approaches. Students will learn about the building blocks of satellites such as sensors, actuators, communication modules and the software protocols used to exchange information between ground station, busses or payload. We will also discuss typical onboard computer systems and their software.

**Real Time Control Systems:** Following the schedule and reacting on time is crucial to mission success. A descending lander far away on a celestial body has to interpret its sensor data within a guaranteed time window. A time delay here could cause an immediate loss of control and the consequence would be a crash.

**Power supply in Aeroplanes and Satellites:** In aerospace technology weight saving is one of the top priorities so there is a need for energy sources with a very high density. Therefore aerospace industry developed a variety of technologies over the past decades. So as the nuclear batteries of the voyager probes will have ensured their continuous operation for more than fifty years. Nevertheless nuclear batteries involve a high risk since during a launch failure radioactive material could fall back down on earth and cause substantial damage to the environment. Students will learn about the diversity of alternative energy sources and how energy is distributed inside an aerospace vehicle during a mission.

**Theories of secondary Batteries:** Just like every functional element a battery can also fail and therefore there is a need for corresponding backup systems. Batteries can be regarded as che-



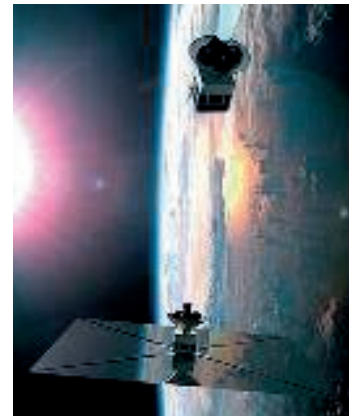


mical plants with a certain functional principle. These functional principles contain certain failure mechanism. Knowing about the chemistry of batteries and the chemical reactions will help to understand the mechanism of failure and provides the possibility to reduce the risk in the future by adjusting the design. Students learn about the details of charging and discharging batteries, possible failure mechanism and accident hazards.

**Control of Quadcopters:** An aircraft needs it for the autopilot, a helicopter and a Quadcopter needs it as well: position controlling. There is a need for systems that can autonomously control the position of an aircraft without the need for human intervention. In case of an autopilot such a system may be used to reduce the stress of a pilot. In case of quadcopters or multicopters it is necessary for realizing the ability to fly at all. Here a human being is not able to set the numerous control signals and the proper parameter values within the limited timeframe anymore. The students will learn about the architecture of Quadcopters with the help of a corresponding development kit for hardware and software as well. During multiple sessions the students will learn about the specific system platform and they will learn how to program a closed loop control in C++ (PID-controller) for that specific setup. The problem will be divided into several steps so that in the end the developed Algorithm will be able to control all 3 axis of the Quadcopter which will allow stable hovering of the quadcopter.

**Introduction to Space Systems:** Satellite missions do not only consist of the satellite. The satellite as payload is only a portion of a much more complex mission. This lecture teaches the basic concepts of rocket engineering and especially drives, launchers, components of a satellite mission and a strategy for designing a satellite mission.

**Space Environment:** Spacecraft operate in an extreme environment. Besides fluctuating temperatures over a wide range the aircraft is always exposed to high-energy radiation (x-ray and particle radiation). Students will learn about the basics of the massive natural influence on the spacecraft. The subject of space debris will also be explained and the fact, that a satellite can become itself a dangerous environmental influence.

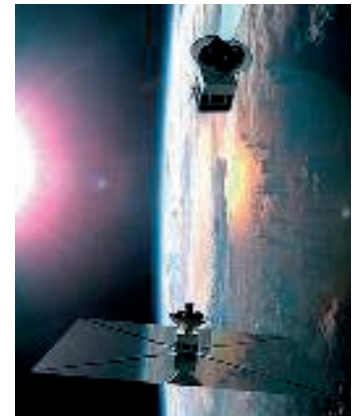




**Basic Principles of Orbital Mechanics and Attitude Control:** Satellites don't move on random orbits. They will be put into position according to the desired purpose. Sometimes it is necessary to lift a satellite from a lower orbit near earth into a more distant geostationary orbit. And sometimes it is necessary to perform a swing-by maneuver in order to initiate a long voyage. The students will learn about the basic concepts of satellite orbits and the referring mathematical methods. This lecture deals with the "Hohmann-Transfer" and its analytical description of a satellite transfer from a low earth orbit into a geostationary orbit. Another subject will be the "Vis-Viva" equation with which we determine the local speed of bodies moving on Keplerian orbits around celestial bodies.



**Satellite Communication:** Terrestrial communication and satellite communication differ in certain aspects. In particular we have to consider signal runtime, disturbances due to atmospheric phenomena and simply the temporary visibility of the communication partners. This lecture will deal with frequency domains, modulation schemes and estimations of the expected performance of a certain sender-receiver-combination. The students will learn about "link budgets" and how it will be calculated from parameters specific of the sender and receiver.



**Power Subsystem:** Besides the previously discussed topic of battery chemistry and suitable energy cells the students will learn about the problems arising due to energy demand in aircraft systems and how to choose and dimension energy cells and solar panels. This lecture will focus on near-earth satellites.



**10th Pico- and Nano Satellite Workshop:** Advances in applying miniaturization technology to satellites offer interesting potential for innovative missions with small satellites. The annual "Pico and Nano satellite workshop" is intended as a platform for knowledge exchange between researchers from all fields of small satellite development. In continuation of the past pico- and nano-satellite workshops, the scope of the workshop is focused on small satellite missions, distributed small satellite systems, subsystem technologies for small satellites, payloads for small satellites, applications and educational aspects of pico- and nanosatellites. We are looking forward to welcome participants and lecturers from Germany, Europe and overseas. The summer school participants will be automatically registered as workshop participants without any additionally fees.





## Course Details

The course duration is two weeks and it will take place from **4–15 September 2017**.

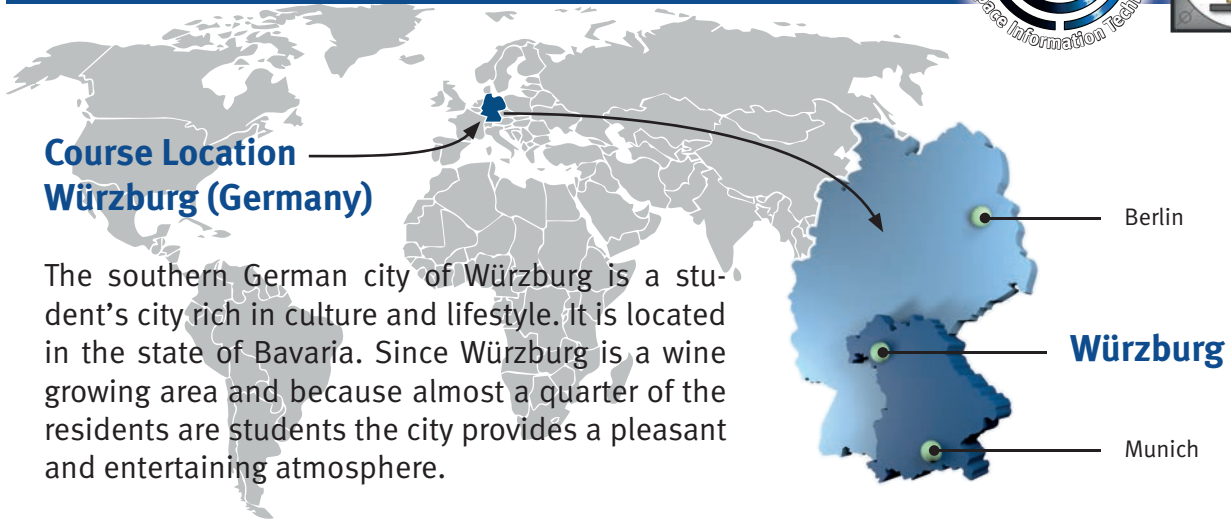
**Start date:** Monday, September 4

## Preliminary Course Schedule

Lectures and exercises are planned to include:

Week 1	Mon – 4 Sep	Tue – 5 Sep	Wed – 6 Sep	Thu – 7 Sep	Fri – 8 Sep	
09:00–10:30	Arrival	Spacecraft System Design III	Excursion 1  ESOC and EUMETSAT Darmstadt	Spacecraft System Design IV	Spacecraft System Design VI	
Break						
11:00–12:30		Space Technology		Spacecraft System Design V	Advanced Sensing and State Estimation III	
Lunch						
13:30–15:00	Spacecraft System Design I	Space Technology			Advanced Sensing and State Estimation I	Advanced Sensing and State Estimation I
Break						
15:30–17:00	Spacecraft System Design II	Space Technology		Advanced Sensing and State Estimation II	Interplanetary Missions: Huygens Rosetta	

Week 2	Mon – 11 Sep	Tue – 12 Sep	Wed – 13 Sep	Thu – 14 Sep	Fri – 15 Sep		
09:00–10:30	Control of Quadcopter	Excursion 2  Space Flight Exhibition Speyer	10th Pico- and Nano-Satellite Workshop	10th Pico- and Nano-Satellite Workshop	Control of Quadcopter		
Break							
11:00–12:30	FloatSat						FloatSat
Lunch							
13:30–15:00	Real Time Systems and Control						Real Time Systems and Control
Break							
15:30–17:00	Space Craft Design				Space Craft Design		
					Farewell		



**Course Location  
Würzburg (Germany)**

The southern German city of Würzburg is a student's city rich in culture and lifestyle. It is located in the state of Bavaria. Since Würzburg is a wine growing area and because almost a quarter of the residents are students the city provides a pleasant and entertaining atmosphere.

The University of Würzburg is one of the oldest institutions of higher learning in Germany having been founded in 1402. Beside Wilhelm Conrad Röntgen who discovered the x-rays there in 1895 there are 14 Nobel laureates affiliated with the university. About 30.000 students are enrolled today.



During their stay the students will get the opportunity to go on 2 full day excursions. The first excursion will go to Darmstadt and the European Space Operations Centre (ESOC). The students will also visit the *Technik Museum Speyer* whose „exhibitions include pieces like the Russian space shuttle Buran, the Concorde and it's Russian counterpart TU-144“ and much more.

All participants of the summer school will stay at the hostel *Babelfish*. For further information please visit [www.babelfish-hostel.de](http://www.babelfish-hostel.de)



## Requirements

The participants must have a higher education entrance qualification and must be enrolled at a university in study paths related to aerospace technology, computer science or engineering. The participants are recommended to refresh their knowledge in C/C++ and higher mathematics. The summer school is for Bachelor's, Master's and PhD students only, good English skills are necessary.

## Scholarships and Fees

There is a participation fee for all participants of 275 € (this fee covers immatriculation, teaching materials, local bus transportation, 2 excursions incl. transportation and admission). Due to the generous financial support of the DAAD (German Academic Exchange Service) different scholarships can be given:

- 5 participants from Guatemala will get 1.850 € each for travel expenses (these scholars have to pay for accommodation and food themselves which will be approx. 500 €)
- 15 participants from Poland or Czech Republic will get 200 € each for travel expenses plus free accommodation, breakfast and lunch.

There is also the possibility to get a partial sponsorship for another 20 students, who unfortunately cannot be granted a scholarship or who are from other countries than listed above. We can offer to them free accommodation, breakfast and lunch.

## Application Procedure

### 1. Send us your complete application form (Deadline: **31 March 2017**)

Please fill in the required form and send it to [Ziegler@informatik.uni-wuerzburg.de](mailto:Ziegler@informatik.uni-wuerzburg.de) by **31 March of 2017** at the latest. With this application form you apply for the summer school and a scholarship at the same time. If you are from one of the following countries you can apply for scholarship: Guatemala, Poland and the Czech Republic. All others can also apply but in case the scholarship will not be granted the students will assume all accumulated costs for accommodation, meals and travelling. You can download the application form at:

<http://www7.informatik.uni-wuerzburg.de/summerschool/>

### 2. Receive the result of the evaluation of your application

Your application will be discussed internally at the University of Würzburg and will be evaluated according to the requirements of the summer school. You will be informed by **21 April of 2017** latest whether your application was successful or not.

### 3. Send us your complete register form

With this register form you supply all necessary information to the administration so your stay here in Würzburg can be organized. You can download the register form at

<http://www7.informatik.uni-wuerzburg.de/summerschool/>

### 4. Receive further information

Once your registration is completed you will receive some useful information concerning your travel and stay.

For further details please contact [ziegler@informatik.uni-wuerzburg.de](mailto:ziegler@informatik.uni-wuerzburg.de)