PROGRAMME INFORMATION

NANOTECHNOLOGY
MASTER OF SCIENCE

NANOBIO TECHNOLOGY
CERTIFICATE

- CHARACTERIZATION OF NANOMATERIALS
- CHIP TECHNOLOGY
- MOLECULAR BIOLOGY
- NANOELECTRONICS
- NANOMAGNETISM
- NANOMATERIALS
- PLASMONICS
- SYNTHESIS OF NANOPARTICLES
- AND MORE
Well-organized web-based communication and interaction enable the students to save time, altogether providing a thoroughly enjoyable, fun-filled and rich learning experience.

DR. CENK AKTAS
GRADUATE OF NANOBIOTECHNOLOGY 2007, HEAD CVD/BIOSURFACES, LEIBNIZ-INSTITUTE FOR NEW MATERIALS

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We would like to thank you for your interest in the distance learning programme “Nano(bio)technology” and present you with this study guide.

The aim of this study guide is to answer the most important questions you may have about our distance learning degree programmes. It will provide you with an overview of the organisational processes including, e.g., information on applications, graduation and programme content. In the first sections, you will receive general information about how the academic programmes are organised as well as the relevant formalities and procedures. Then, we will present the necessary examination prerequisites and components, content of the programmes and information on the authors of the learning materials.

From the winter semester 2020/21, the Master programme “Nanotechnology” will no longer be offered. The study guide is currently being revised.

The final section includes general information on the Technische Universität Kaiserslautern (TUK). We hope that this guide will provide you with all the necessary information and help you make an informed decision about your future distance learning degree programme.

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**ENRIQUE D. KREFF**

Graduate of Nanobiotechnology 2011, Research Scientist at Dupont Pioneer
WHAT CONSTITUTES ADVANCED SCIENTIFIC STUDY?

ADVANCED SCIENTIFIC TRAINING

> assumes an ability to study,
> assumes experience in scientific and academic work,
> expects a willingness to discuss other viewpoints,
> uses scientific language that is not always immediately accessible to a lay audience,
> expects a willingness to reflect on and interact with other linguistic forms and ways of thinking.

Do not expect easily “consumable” or “digestible” knowledge. Advanced scientific training imparts scientific theories as well as sound strategies and tools that can be reflected on and applied in your own professional career.

The field of advanced training offers a whole range of different training opportunities. They can be distinguished by, e.g., their different target audiences. Some courses do not require any special educational prerequisites and can be taken by any interested and willing applicant. Other providers of advanced training, however, develop special courses that are aimed at a select group of people.

This limitation is due to the fact that some educational programmes require a certain degree of prior knowledge for successful completion. This also applies to “advanced scientific training”. Even though, in principle, no one should be excluded from insights and knowledge gained through science and research, it is nonetheless impossible to waive certain requirements for participation. In general, this includes a willingness to acquire the language of science. In particular, however, applicants require the basic scientific knowledge of the respective subject to be studied.

» Even if you have many commitments both at work and home, a distance learning degree at DISC enables you to make your postgraduate learning goals a reality.
DISTANCE LEARNING PROGRAMMES AT DISC: “INDEPENDENT LEARNING”

Distance learning programmes are basically defined by the fact that students do not physically attend the institution of higher education but, instead, the institution of higher education comes to them. The notion of “independent learning” is fundamental to the design of advanced distance learning programmes at DISC. Our students become experts of their own learning process, which results in a sustainable consolidation and increase of their domain-specific knowledge.

The DISC concept is essentially based on self-study phases that are consolidated and enhanced through on-campus phases. Both programme organisation and the didactically prepared learning materials and formats are based on the concept of independent learning. Each academic programme has an own virtual learning environment in the online campus that accompanies students for the duration of their programme and includes the following elements:

**Self-study material**, specifically developed for this academic programme, includes: substantiated and practice-oriented content, learning and reflection tasks with exemplary solutions, glossaries and tips for further reading. Relevant texts and additional learning materials are available for students online. Key, text-based learning materials can be accessed through the Print-on-Demand service: You can commission one of our printing service providers to print, bind, and send you the materials.

**Supervised online learning**
The self-study phases are supervised in the online learning environment. The following interaction, communication and information channels are available:
- Communication forum for exchanges with peers and supervisors;
- Organisation of programme: information on examination prerequisites and components (e.g. information on writing a MA thesis), registration for on-campus sessions, overview of dates and deadlines, submission of examination prerequisites.

Depending on the academic programme and semester, some compact courses, such as online seminars, colloquia or tutorials, may also be held in the online environment. These services are contingent on the requirements of the programme and learning objectives.

The aim of on-campus phases, which take place once per semester during the first until the fifth semester, is to consolidate the learned content and, if applicable, take examinations.

**OBJECTIVES OF THE DISTANCE LEARNING PROGRAMME**

Nanotechnology and nanobiotechnology are both highly interdisciplinary fields as they combine physical laws, chemical properties, and biological principles on the nanoscale. Hence, there are already many examples of chemists, biologists, physicists and engineers with various specialisations who are closely collaborating in this field. It is virtually impossible to promote genuinely innovative developments using knowledge from just one of these subject areas. Therefore, it is an inescapable fact that any scientist or engineer wishing to join this new discipline must acquire additional knowledge in other specialist areas. The “Nanotechnology” Master’s distance learning programme lasts for six semesters and includes instruction in: semiconductor theory, quantum information processing, characterization techniques of nanostructures, screening methods in biology, nanooptics, biomaterials for transplantation, manufacturing of ceramics and composites, the use of nanoparticles for drug delivery, nanoelectronics and nanomagnetism. This allows you to choose classes based on your professional goals, be they in the semiconductor and electronics industry, IT, the automotive industry, the chemical industry, biotechnology companies, optics and laser technology, the pharmaceutical industry, medicine and medical technology or the development and manufacture of new materials. The “Nanobiotechnology” Certificate distance learning programme lasts for two semesters and combines chemical nanotechnology, nanomaterials and biotechnology. These three technologies are expected to have an extraordinary impact on future scientific developments. This means graduates of this distance learning programme will have the potential to enter any professional field where there is a demand for knowledge about developing new materials with multi-functional properties.

**PROGRAMME DURATION**

The standard period of study in the distance learning programme “Nanotechnology” is six semesters, including examinations. Students require a total of 90 credit points to complete the programme. The programme starts in October every year.

The standard period of study in the distance learning programme “Nanobiotechnology” is two semesters, including examinations. Students require a total of 43 credit points to complete the programme. The programme starts in October every year.

**TARGET GROUP**

Both the “Nanotechnology” and “Nanobiotechnology” distance learning programmes at the TUK are aimed at graduates in engineering, natural sciences, pharmacy and medicine. If you have an engineering, natural sciences or medicine degree, you may fulfil the admission requirements for one or both of the programmes.

Since both programmes are thematically similar and share some teaching materials and laboratories, you should consider not only the course content but also the target group for each programme:

The “Nanotechnology” Programme targets graduates of a university or a university of applied sciences with a degree in natural sciences, pharmacy or medicine and who already work in a relevant field. This is a fully fledged Master of Science (M.Sc.) programme as opposed to the “Nanobiotechnology” Programme. This programme includes more on-campus weekends with lab work and requires students to write a Master’s thesis during the final semester.

The “Nanobiotechnology” Certificate Programme is also targeted at graduates of a university or university of applied sciences with a degree in natural sciences, pharmacy or medicine but specifically at graduates who do not strive for a further academic degree. Instead, it is aimed at professionals who need continuing education in the field of nanobiotechnology.
OBJECTIVES, STRUCTURE AND ORGANISATION

ADMISSION REQUIREMENTS

1. ADMISSION WITH AN UNIVERSITY DEGREE

The requirement for admission to the “Nanotechnology” Master’s programme is a completed undergraduate degree in either engineering, natural sciences, pharmacy or medicine earned from a university or university of applied sciences. A minimum of one year’s relevant work experience after the first degree is also required. As part of the application for admission to the distance study programme “Nanotechnology”, applicants must make a written declaration stating that an appropriate institution has agreed to allow them to do their Master’s thesis at that institution. The appropriate documentation from the facilitating institution is to be provided to the Department of Distance Study Affairs before the end of the fourth semester. For this purpose the provided declaration form must be submitted to the Department of Distance Study Affairs prior to the application deadline.

To apply for the “Nanobiotechnology” Certificate programme, you must also have a minimum of a Bachelor’s degree in a relevant field from an accredited university or university of applied sciences.

PROOF OF ENGLISH PROFICIENCY


APPLICATION AND ENROLMENT

The application period is generally from mid-May to mid-July. Both programmes start in the winter semester. Current enrolment dates and the application deadlines for upcoming semesters are available from DISC or the Department of Distance Study Affairs at the TUK. The required application documents can also be requested there. For more information on enrolment, please go to: www.zfuw.de/application

You can discontinue or interrupt your distance learning programme at the end of each semester. The associated certificates of de-registration or leave of absence will also be issued at the end of the semester. The registration fee and the tuition fee cannot be reimbursed in the case of withdrawal after successful admission to the programme. Many students experience periods in which they need to focus more strongly on their careers or families while enrolled in an academic programme. Experience has shown that it is nonetheless possible to successfully graduate from the programme despite other commitments. Contact the programme officers in time so that they can potentially help you to find an individual solution in order to avoid interrupting or even discontinuing your academic programme.

STUDY INTERRUPTION

You can discontinue or interrupt your distance learning programme at the end of each semester. The associated certificates of de-registration or leave of absence will also be issued at the end of the semester. The registration fee and the tuition fee cannot be reimbursed in the case of withdrawal after successful admission to the programme. Many students experience periods in which they need to focus more strongly on their careers or families while enrolled in an academic programme. Experience has shown that it is nonetheless possible to successfully graduate from the programme despite other commitments. Contact the programme officers in time so that they can potentially help you to find an individual solution in order to avoid interrupting or even discontinuing your academic programme.

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2. ADMISSION WITH A PROFESSIONAL QUALIFICATION

Applicants who have relevant work experience but no university degree may also be accepted. They must hold a university entrance qualification, be able to certify several years of relevant work experience and pass an aptitude test. More information about the admission requirements and the aptitude test can be found on the DISC website. The registration deadline for admission to the aptitude test ends on 31 January of each year.

COSTS

The current tuition fee for the advanced distance learning Master’s programme “Nanotechnology” is 820 Euro per semester (plus the registration fee of currently 102 Euro per semester) as well as a one-time fee for the Master’s Thesis of currently 500 Euro.

The current tuition fee for the advanced distance learning Certificate programme “Nanobiotechnology” is 820 Euro per semester (plus the registration fee of currently 102 Euro per semester).

In accordance with the applicable DISC fee structure, tuition fees are reduced to 30 percent as of the third semester exceeding the standard period of study. This does not apply to the fee for the Master’s thesis. This covers, among other things, the costs for online learning materials, on-campus phases and administrative fees.

Tuition fees are charged every semester, depending on your enrolment or re-registration status. If you are enrolling for the first time, it is very important that you do not transfer the tuition fee until you have received your letter of admission.

We try to ensure that our study guide is always up-to-date. Despite regular revisions, information on costs and programme content may deviate due to short-term amendments. We therefore kindly ask that you visit our website for information on the current programme conditions prior to submitting your application.

Furthermore, you can also use our online learning environment to commission one of our printing service providers. For a surcharge, they will print, bind and send you the available learning materials (print-on-demand). Additional costs that are not included in the tuition fee may be incurred due to the on-campus phases (bed, board, transport, etc.).
The state offers individual tax incentives in Germany for advanced training measures. Depending on your personal income and job situation, you may be able to offset the costs of your distance learning programme as advertising expenses or special expenses and receive a partial or full refund. For more information, please contact an independent expert or your local tax authority. Unfortunately, financial support cannot be granted in accordance with the Sozialgesetzbuch - Drittes Buch (SGB III) (Social Security Code - Book Three) or the Bundesausbildungsförderungsgesetz (BaföG) (Federal Training Assistance Act). Further information on support measures can be accessed at www.zfuw.de/sponsorship as well as in the DGWF brochure “Fördermöglichkeiten in der Weiterbildung” (Support measures for advanced training), which is available in the download area (in German only).

Please also consult with relevant authorities in your home country or international organisation for information on additional support measures.

Students with disabilities or severe disabilities can receive disadvantage compensation to counterbalance disability-related disadvantages. Disadvantage compensation is normally only granted once students submit proof of a severe disability as well as further conditions (marks). For more information, please contact the programme officer.

Many students are also parents and want to combine their family life with their academic programme or career. TUK is dedicated to improving the conditions for reconciliation of academic programme/science and family life. Our services include, among other things, an appealing family room that can be used by parents who study or work at the TUK as well as by students in distance learning programmes during the on-campus phases. Furthermore, we offer free online courses such as e.g. “Work-Life-Learn-Balance”. For more information, please contact the programme manager.
OBJECTIVES, STRUCTURE AND ORGANISATION

WORKLOAD

Experience has shown that forming voluntary learning groups is beneficial to our students. In these groups, students can regularly discuss the learning materials and help each other prepare for examinations. Our online learning environment also supports students in organising car pools and founding learning groups either at the beginning of the academic programme or during your programme’s kick-off event in the first semester. We further provide students with the opportunity to share experiences and information, or to simply become better acquainted, in our online discussion forums or during the kick-off event.

Four modules are offered per semester in the advanced distance learning Certificate programme “Nanobiotechnology”. In this case, each module also normally consists of one to two study packages.

It is estimated that the “Nanotechnology” Programme requires approximately 15–20 hours of study time per week and the “Nanobiotechnology” Programme around 10–18 hours per week. This time is particularly crucial at the start of the course since, as a general rule, it will take more time to find your personal working and learning style, and to get used to the course contents and online learning environment.

The actual study time required depends on a number of factors: your individual study habits, your personal and professional situation, and your prior knowledge. The “Nanotechnology” Programme also requires five on-campus weekends; the “Nanobiotechnology” Programme requires two such weekends.

Obviously, it is highly unlikely that you will be able to continue your previous activities and hobbies in the same manner if you intend to properly complete the required course work. We strongly advise that you realistically assess your working capacity, your interests and existing time commitments before applying for one of these programmes.

ON-CAMPUS PHASES

An on-campus phase takes place at the end of each semester for all participants in both programmes; the exception is the last semester of the “Nanotechnology” Master’s programme. All on-campus phases are scheduled in a compact format: two-day chunks which are held on weekends. An additional voluntary event takes place typically in October or November at the start of the programme. The goal is to become acquainted with the university, the online-tutorials and fellow students. A few months before any on-campus event, you will receive the schedule. On-campus weekends give you an opportunity to do more in-depth study, take your written exams and do the practical lab work. It’s also an important opportunity to meet your fellow students, share experiences and form learning groups. The DISC takes no responsibility for accommodation during on-campus weekends, but we do offer assistance in your search.

ONLINE LEARNING ENVIRONMENT & LEARNING MATERIALS

The online learning environment is a central component of the distance learning programme and provides, e.g., information on important semester dates and organisation of the distance learning programme as well as examination registrations, access to materials, and an opportunity to connect with other students. All learning materials are uploaded to the online environment and students can register for the on-campus phases here as well. You also have the possibility to discuss and connect with other students here.

The written learning materials were developed specifically for the distance learning programme and constitute a key component of independent self-study. For this reason, the documents have a self-explanatory structure. The materials include all significant factual information on the topic and have been didactically and formally designed in such a way as to enable independent and autonomous knowledge acquisition.

For enrolled students, the learning material is available online as a PDF download.

You can also use our print-on-demand service to commission one of our printing service providers to print, bind, and send you the materials.

Our distance learning students can find the materials on the password-protected learning platform OpenOLAT. You can access the respective semester’s necessary documents after the beginning of the semester.
STRUCTURE OF THE LEARNING MATERIALS

The materials include a table of contents followed by a glossary that clarifies domain-specific terminology as well as all foreign words necessary to understand the text for study. The list of references can be found after the brief introduction to the authors. Then, the learning objectives - that are of significant importance for all distance learning students - are defined. Finally, the objectives are followed by the actual text for study. In turn, the text for study contains formulas and exercises. You can independently check the solutions to the exercises with the help of the respective solutions or hints in the appendix. The marginalia (side notes) make the text for study more accessible by providing summaries on the state and progress of the text. In addition, you can use the space for own comments and amendments. The texts for study also contain information on further recommended reading. In the appendix, you will find supplementary and/or explanatory information, images, flow charts, source texts etc. that could not be included in the actual text for study.

GRADUATION

Once you have completed all the requirements for the “Nanotechnology” programme, you will be awarded a “Master of Science” (M.Sc.) diploma.

THE SUCCESSFUL COMPLETION OF THE MASTER’S PROGRAMME “NANOTECHNOLOGY” IS CERTIFIED BY THREE DOCUMENTS:
- transcript of grades
- certificate of the award of the academic degree “Master of Science” (M.Sc.) with the overall grade
- Diploma Supplement in English

A Diploma Supplement is issued by most universities in the European Union to provide an overview of the university and grading structure within each country along with explanatory information about each specific university’s course requirements and grading methods.
The “Nanotechnology” Programme is divided into three segments: the basic course (first semester), advanced studies (second-fifth semesters) and the Master’s thesis (sixth semester). The entire programme consists of 14 modules plus the Master’s thesis. Three modules are optional but you must choose one: Quantum Information Processing (second semester), Nanomaterials 2 (fourth semester), or Applications of Nanotechnology (fifth semester). The following table lists the subjects for each module, study requirements and exams. The on-campus weekends conclude with written examinations which will be graded. You will receive ungraded performance records for all mail-in exercises. The thesis is usually written during the sixth semester with a six-month window for completion. If you have not yet passed all the necessary examinations when registering for the thesis phase, the following documents have to be submitted: evidence you have successfully completed the first two semesters; evidence you have successfully passed two of the necessary exams from the third-fifth semesters, and evidence of participation in two on-campus events from the third-fifth semesters. The external Master’s thesis work required by this programme must be approved by the Examination Board (Prüfungsausschuss). You should allow sufficient time for the Examination Board to authorize any equipment and the supervisory situation associated with your thesis.

<table>
<thead>
<tr>
<th>SEM.</th>
<th>MODULE (CREDITS)</th>
<th>SUBJECT</th>
<th>ASSESSMENT</th>
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<tbody>
<tr>
<td>1</td>
<td>Fundamentals of Quantum Mechanics (5)</td>
<td>&gt; Fundamentals of Quantum Mechanics</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>1</td>
<td>Fundamentals of Molecular Biology, Genetics (5)</td>
<td>&gt; Fundamentals of Molecular Biology, Genetics</td>
<td>Written exam</td>
</tr>
<tr>
<td>1</td>
<td>Solid State Physics (5)</td>
<td>&gt; Solid State Physics</td>
<td>Written exam</td>
</tr>
<tr>
<td>1</td>
<td>Belongs to: Fundamentals of Molecular Biology and Solid State Physics modules</td>
<td>&gt; Solid State Physics and Molecular Biology</td>
<td>On-campus phase</td>
</tr>
<tr>
<td>2</td>
<td>Technology of MEMS and NEMS (6)</td>
<td>&gt; Technology of Micro- and Nanoelectromechanical systems</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td></td>
<td>Lab in the Cleanroom</td>
<td>On-campus phase</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Physics option: Quantum Information Processing (5)</td>
<td>&gt; Quantum Information Processing</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>2</td>
<td>Semiconductor Theory and Device Physics (5)</td>
<td>&gt; Semiconductor Theory and Device Physics</td>
<td>Written exam</td>
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<thead>
<tr>
<th>SEM.</th>
<th>MODULE (CREDITS)</th>
<th>SUBJECT</th>
<th>ASSESSMENT</th>
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</table>
| 3    | Analytical Techniques in Nanotechnology (12) | > Characterization of Nanostructures  
> Screening Methods in Biology, Chip Technologies | Written exam |
|      |                   | > Characterization of Nanostructures  
> On-campus phase | |
| 3    | Nanooptics (6)   | > Metamaterials and Photonic Crystals  
> Plasmonics | Written exam |
| 4    | Nanomaterials 1 (7) | > Processing Ceramics and Composites and their Applications  
> Physical and Chemical Synthesis of Nanoparticles | Written exam |
| 4    | Chemistry option: Nanomaterials 2 (5) | > Nanotechnologically Modified Biomaterials  
> Carbon Nanomaterials | Mail-in assignments |
| 4    | Belongs to: Analytical Techniques in Nanotechnology module | > Screening Methods in Biology, Chip Technologies | On-campus phase |
| 4/5  | Nanomaterials 3 (5) | > Self-assembly  
> Computer Simulations and Modeling in Nanotechnology | Mail-in assignments |
| 5    | Transport in Nanostructures (7) | > Nanoelectronics  
> Nanomagnetism | Written exam |
|      |                   | > Nanoelectronics  
> On-campus phase | |
| 5    | Biology option: Applications of Nanotechnology (5) | > Molecular Nanosystems: Sensors and Molecular Motors  
> Nanoparticles as Therapeutic Drug Carrier and Diagnostics | Mail-in assignments |
| 5    | Nanotechnology in its Societal Context (2) | > Nanotechnology in its Societal Context | Mail-in assignments |
| 6    | Master’s Thesis (20) |                   | |
### Certificate Programme at a Glance

This course consists of 12 subjects and two on-campus weekends. The following table lists the required subjects along with criteria for completion.

<table>
<thead>
<tr>
<th>SEM.</th>
<th>SUBJECT</th>
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<tbody>
<tr>
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<td>Fundamentals of Quantum Mechanics</td>
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<td>Fundamentals of Molecular Biology, Genetics</td>
<td>Written exam</td>
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<td>1</td>
<td>Molecular Nanosystems: Sensors and Molecular Motors</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>1</td>
<td>Nanoparticles as Therapeutic Drug Carrier and Diagnostics</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>1</td>
<td>Characterization of Nanostructures</td>
<td>Written exam</td>
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<tr>
<td>1</td>
<td>Screening Methods in Biology, Chip Technologies</td>
<td>Written exam</td>
</tr>
<tr>
<td>1</td>
<td>Screening Methods in Biology, Chip Technologies</td>
<td>On-campus phase</td>
</tr>
<tr>
<td>2</td>
<td>Processing Ceramics and Composites and their Applications</td>
<td>Written exam</td>
</tr>
<tr>
<td>2</td>
<td>Physical and Chemical Synthesis of Nanoparticles</td>
<td>Written exam</td>
</tr>
<tr>
<td>2</td>
<td>Processing Coatings and their Applications</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>2</td>
<td>Interaction between Biological and Non-biological Devices</td>
<td>Written exam</td>
</tr>
<tr>
<td>2</td>
<td>Nanotechnologically Modified Biomaterials</td>
<td>Mail-in assignments</td>
</tr>
<tr>
<td>2</td>
<td>Characterization of Nanostructures</td>
<td>On-campus phase</td>
</tr>
</tbody>
</table>
### Labs Held During On-Campus Weekends

<table>
<thead>
<tr>
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<th>“NANOTECHNOLOGY”</th>
<th>“NANOBIOTECHNOLOGY”</th>
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<tbody>
<tr>
<td>1</td>
<td>Solid State Physics and Molecular Biology</td>
<td>Analytical Techniques in Nanotechnology (Screening Methods in Biology, Chip Technologies)</td>
</tr>
<tr>
<td></td>
<td>Department of Physics, TU Kaiserslautern</td>
<td>Institute of Technical Chemistry, University of Hannover</td>
</tr>
<tr>
<td></td>
<td>UV-Photolithography and Lift-off</td>
<td>Department of Physics, TU Kaiserslautern</td>
</tr>
<tr>
<td>3</td>
<td>Analytical Techniques in Nanotechnology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Department of Physics, TU Kaiserslautern</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Analytical Techniques in Nanotechnology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Screening Methods in Biology, Chip Technologies)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Institute of Technical Chemistry, University of Hannover</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Transport in Nanostructures (Nanoelectronics)</td>
<td>Forschungszentrum Jülich</td>
</tr>
</tbody>
</table>
NANOTECHNOLOGY
The Master's degree programme in Nanotechnology consists of two phases: the core phase and the advanced phase. The first phase, or "core phase", lasts for one semester and includes three modules. The "advanced phase" follows the core phase and covers eleven modules. The average student weekly workload is approx. 15-20 hours. Students complete the required examination components during the course of the programme in the form of examinations, mail-in assignments or by taking part in practical trainings or tutorials during the on-campus weekends that take place once per semester. The "core phase" is identical for all students and establishes the foundation for the subsequent advanced phase of the programme. There are currently three different fields of study to choose from: Quantum Information Processing, Nanomaterials 2 und Applications of Nanotechnology. Each participant must select one of these fields.

1st SEMESTER
- one mail-in assignment
- two written examinations
- one on-campus phase

2nd SEMESTER
- one mail-in assignment
- if applicable, a second mail-in assignment (depending on the selected field)
- one written examination
- one on-campus phase

3rd SEMESTER
- two written examinations
- one on-campus phase

4th SEMESTER
- one mail-in assignment
- if applicable, two more mail-in assignments (depending on the selected field)
- one written examination
- one on-campus phase

5th SEMESTER
- two mail-in assignments
- if applicable, a second mail-in assignment (depending on the selected field)
- one written examination
- one on-campus phase

All end-of-semester on-campus events culminate in written examinations for which students receive grades. The mail-in assignments, which must be submitted to DISC, are ungraded coursework.

NANOBIOTECHNOLOGY
The Certificate programme in Nanobiotechnology lasts for two semesters. The average student's weekly workload is approx. 10-18 hours. Students complete the required examination components during the course of the programme in the form of examinations, mail-in assignments or by taking part in practical trainings or tutorials during the on-campus weekends that take place once per semester.

1st SEMESTER
- two mail-in assignments
- two written examinations
- one on-campus phase

2nd SEMESTER
- two mail-in assignments
- two written examinations
- one on-campus phase

All end-of-semester on-campus events culminate in written examinations for which students receive grades. The mail-in assignments, which must be submitted to DISC, are ungraded coursework.
**PROGRAMME CONTENT**

**NT0001: FUNDAMENTALS OF QUANTUM MECHANICS (NT, NBT)**
Author: Prof. Dr. Hans-Jürgen Korsch

The module consists of one study package. The study package “Fundamentals of Quantum Mechanics” covers, among other things, the following aspects:
- Classical and quantum physics
- The Schrödinger equation
- One-dimensional systems
- Two- and three-dimensional systems
- Time-dependent phenomena

**NT0002: FUNDAMENTALS IN MOLECULAR BIOLOGY, GENETICS (NT, NBT)**
Authors: Dr. Angelika Roth and Dr. Peter Reichmann

The module consists of one study package. The study package on “Fundamentals in Molecular Biology” discusses the following aspects:
- Basics in chemistry
- DNA and RNA
- From amino acids to proteins
- The flow of genetic information
- Molecular biology of gene functions
- Regulation of gene expression
- Alteration of genetic information
- Recombinant DNA technology
- Important techniques in molecular biology
- Genomics
- Biology in the computer age

**NT0003: SOLID STATE PHYSICS (NT)**
Author: Dr. Wilhelm Kulisch

Among other things, the study package “Solid State Physics” covers the following:
- Chemical bonding in solids
- Structure of crystalline solids
- Diffraction from periodic structures
- Dynamics of atoms in a periodic crystal
- Thermal properties of solids
- Free electrons in a solid
- Magnetism
- Motion of electrons and transport phenomena
- Dielectric properties of solids
- Semiconductors
- Superconductivity

**NT0004: TECHNOLOGY OF MICRO- AND NANOELECTROMECHANICAL SYSTEMS (NT)**
Author: Dr. Sandra Wolff

Some topics of the study package “Technology of Micro- and Nanoelectromechanical Systems” are:
- Semiconductor road map
- Technologies
  - Deposition: chemical/physical vapour deposition, plasma assisted deposition, epitaxial growth
  - Structuring: wet etching, dry etching (sputtering, reactive ion etching), focused ion beam milling
- Structure definition: photolithography (UV, EUV), particle lithography (E-Beam, FIB), soft lithography, nanoimprinting, nanoscribing
- Next Generation Lithography (NGL):
  - MEMS /NIEMS (micro- and nanoresonator)

**NT0005: QUANTUM INFORMATION PROCESSING (NT ELECTIVE MODULE)**
Author: Prof. Dr. Artur Widera

The module consists of one study package. The study package on “Quantum Information Processing” discusses the following aspects:
- Single qubit operations
- Quantum correlations and two-qubit operations
- Quantum cryptography
- Quantum algorithms and quantum computation

**NT0006: SEMICONDUCTOR THEORY AND DEVICE PHYSICS (NT)**
Author: Prof. Dr. Hans Christian Schneider

Among other things, the study package “Semiconductor Theory and Device Physics” covers the following:
- Electromagnetic fields and many–level systems
- Crystal structures and the reciprocal lattice
- Electronic band structures in semiconductors: general methods
- Electronic states and transitions around the gap
- Phonons and elasticity theory
- Optical properties of semiconductors

**NT0007: ANALYTICAL TECHNIQUES IN NANOTECHNOLOGY (NT, NBT)**
Authors: Prof. Dr. Christiane Ziegler, Dr. Christine Müller-Renno, Prof. Dr. Roland Ulber and Dr. Frank Stahl

This module consists of two study packages. The first package, “Characterization of Nanostructures”, discusses the following aspects:
- Prerequisites for resolution on the nanometre scale
- Overview on experimental aspects
- Microscopic techniques
- Spectroscopic techniques: electronic structure
- Spectroscopic techniques: vibrating and magnetic structures
- Spectroscopic and spectrometric techniques: chemical composition

The second package “Screening Methods in Biology, Chip technologies” covers the following:
- Traditional screening of genes and gene expression
- High-throughput screening
- Chip technologies
- Gene expression analysis by RNA Seq
- Protein chip technologies
- Aptamer microarrays
- Cell and tissue microarrays
- Lab-on-a-ship
The second package, "Plasmonics", covers the following topics:
- The optical properties of metals
- Surface plasmon polaritons
- Localized surface plasmons

Selected applications of nanoplasmonics:
- nanoantennas

The topics of the second study package "Carbon Nanomaterials" are mandatory for students in the Master's programme and focus on the following:
- Synthesis of carbon nanomaterials
- Purification, separation, and characterization of carbon nanomaterials
- Handling of carbon nanomaterials
- Safety

The second study package "Computer Simulations and Modeling in Nanotechnology" is dedicated to the following:
- Interatomic interaction
- Molecular statics
- Molecular dynamics
- Computational chemistry

Stochastic techniques
- Molecular orbitals and binding
- A primer on quantum chemistry

The second study package is on the topic of "Nanomagnetism" and focuses on:
- Basics of magnetism
- Techniques to measure magnetic properties
- Simulations of static and dynamic micro- and nanomagnetic phenomena

Magnetic nanoparticles
- Magnetic nanowires
- Two-dimensional magnetic nanostructures
- Three-dimensional magnetic nanomaterials
The second package, "Molecular Nanosystems: Molecular Motors", covers the following topics:

- Importance of movement for living systems
- ATP synthase
- Kinesin, dynein and myosin: motors for linear, intracellular transport

The third part of the study package "Nanoparticles as therapeutic drug carrier and diagnostics" covers:

- Features of polymeric nanoparticles
- Preparation and characterization of nanoparticles
- Recent developments in pharmaceutical nanoparticles technology
- Therapeutic applications of nanoparticulate carrier systems
- Nanoparticles as diagnostics

Among other things, the study package "Nanotechnology in its societal context" covers the following:

- Approaching nanotechnoscience
- The incredible tininess of nano
- The nanomachinery of life
- From dead matter to smart materials
- Nanomagic
LIST OF AUTHORS

EXCERPT

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Kaiserslautern, study package NT0006
Semiconductor Theory and Device Physics

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Kaiserslautern, study package NT0004 Technology
of Micro- and Nanoelectromechanical Systems

PROF. DR. ARTUR WIDERA,
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Quantum Information Processing

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Characterization of Nanostructures

DR. FRANK STAHL,
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Screening Methods in Biology, Chip Technologies

PROF. DR. GEORG VON FREYMANN,
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Professor of experimental physics at the
TU Kaiserslautern, study package NT0008
Metamaterials and Photonic Crystals

PROF. DR. EINAR KRUIS,
Academic Director for nanostructure technologies
at the University Duisburg-Essen, study packages
NT0009 Physical Synthesis of Nanoparticles
and Chemical Synthesis of Nanoparticles

PROF. DR. EVA EISENBARTH,
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South Westphalia University of Applied
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Nanotechnologically Modified Biomaterials

PROF. DR. HERBERT URBASSEK,
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Kaiserslautern, study package NT0011 Computer
Simulations and Modeling in Nanotechnology

PROF. DR. THOMAS HEINZEL,
Professor for condensed matter physics
at the University of Düsseldorf, study
package NT0012 Nanoelectronics
The physics department has existed since the university was founded in 1970 as part of the twin University of Trier-Kaiserslautern (see below). The physics department is divided into 18 groups.

EXPERIMENTAL PHYSICS:
Ultrafast phenomena at surfaces, biophysics and ultrafast spectroscopy, physics and technology of nanostructures, ultra-cold quantum gases, biophysics and medical physics, individual quantum systems

APPLIED THEORETICAL PHYSICS:
Integrated optoelectronics and microoptics, magnetism

TECHNICAL PHYSICS/COMPUTER SIMULATION:
Computer simulation and material sciences

THEORETICAL PHYSICS:
Foundations of quantum physics, fundamentals of solid-state and many body systems, quantum optics, condensed matter theory, theoretical semiconductor optics

EXPERIMENTAL PHYSICS/TECHNICAL PHYSICS:
Ultrasound phenomena at surfaces, biophysics and ultrafast spectroscopy, physics and technology of nanostructures, ultra-cold quantum gases, biophysics and medical physics, individual quantum systems

TECHNICAL PHYSICS:
Interfaces, nanomaterials and biophysics, optical technologies and photonics

DIDACTICS:
Didactics of physics

THE FOLLOWING DEGREES/CERTIFICATES ARE OFFERED BY THE DEPARTMENT OF PHYSICS:
- Bachelor and Master in Physics (B.Sc./M.Sc.)
- Bachelor and Master in Biophysics (B.Sc./M.Sc.)
- Bachelor and Master in TechnoPhysics (B.Sc./M.Sc.)
- Bachelor and Master of Education in Physics (B.Ed./M.Ed.)

DISTANCE STUDY PROGRAMMES:
- Master of Science in Medical Physics
- Certificate in Medical Physics and Technology
- Master of Science in Nanotechnology
- Certificate in Nanobiotechnology

The following degrees/certificates are offered by the department of physics:
- Bachelor and Master in Physics (B.Sc./M.Sc.)
- Bachelor and Master in Biophysics (B.Sc./M.Sc.)
- Bachelor and Master in TechnoPhysics (B.Sc./M.Sc.)
- Bachelor and Master of Education in Physics (B.Ed./M.Ed.)

The distance study programmes are a collaborative effort between the Department of Physics, the Department of Electrical Engineering and Information Technology, and the DISC, which organizes and runs these programmes. In addition, individual physics courses for students in other disciplines are offered. The Nano Structuring Center (NSC) is located in the Department of Physics.

The existing expertise in the field of nanotechnology in the physics department was recognized with the establishment of the State Research Center OPTIMAS (optics and materials science) in 2008. OPTIMAS consists of research groups from the university departments of Physics, Chemistry, Electro and Computer Engineering as well as Mechanical and Process Engineering. In addition, the department "Materials Characterization and Testing" of the Fraunhofer Institute for Physical Measurement Techniques (IPM), the Nano Structuring Center (NSC) of the TUK, the Institute for Surface and Thin Film Analysis (IFOS), the Institute for Composite Materials (IVW), and the Photonik-Zentrum Kaiserslautern (PZKL) are partners of OPTIMAS.

OPTIMAS members are part of many cutting-edge national and international research programmes. OPTIMAS seeks to expand the nationally and internationally recognized research and training programmes at the TUK which focus on quantum optics, photonics, spintronics, molecular/magnetic functional materials and nanostructures.

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PARTICIPATING INSTITUTIONS

DISTANCE AND INDEPENDENT STUDIES CENTER

The DISC was founded as the Zentrum für Fernstudien und Universitäre Weiterbildung in 1992 and is a key scientific department of the TUK. The DISC incorporates the three areas: Zentrum für Fernstudien und Universitäre Weiterbildung (ZFUW, Center for Distance Studies and Advanced University Training), eTeaching Service Center (eTSC) and Selbstlehrzentrum (SLZ, self-directed study center) that each addresses the overarching range of DISC tasks in various fields: distance learning, e-teaching support and self-study skills.

The range of measures that are offered in cooperation with the individual subjects and departments at the TUK include postgraduate distance learning programmes of varying duration and with different degrees. All distance learning programmes can be taken as dual study programmes. More than 4,300 students from Germany, Europe and the rest of the world are currently enrolled in the following academic programmes:

**“HUMAN RESOURCES” DEPARTMENT**
- Adult Education (Master of Arts)
- Human Resources Development (Master of Arts)
- Organizational Development (Master of Arts)
- School Management (Master of Arts)
- Social Sciences: Organisation and Communication (Master of Arts)
- Systemic Consulting (Master of Arts)
- Systemic Management (Certificate)

**“MANAGEMENT & LAW” DEPARTMENT**
- Commercial Law for Business Practice (Master of Laws)
- Economy and Management (Master of Arts)
- Management of Cultural and Non-Profit Organisations (Master of Arts)
- Management of Health and Social Institutions (Master of Arts)
- Master of Evaluation (Master of Arts)
- Sustainable Development Cooperation (Master of Arts)
- Tax Law for Business Operations (Master of Laws)

**“SCIENCE & ENGINEERING” DEPARTMENT**
- Financial Engineering (Master of Science)
- Fire Protection Planning (Master of Engineering)
- Medical Physics (Master of Science)
- Medical Physics and Engineering (Certificate)
- Nanobiotechnology (Certificate)
- Nanotechnology (Master of Science)
- Psychology of Developmental and Learning Disorders in Children (Master of Science)
- Software Engineering for Embedded Systems (Master of Engineering)

Additional to the above mentioned academic programmes the DISC offers certificate courses. We are constantly increasing our range of offered programmes. Further information is available at www.zfw.de.
Since 1986, when Gerd Binning and Heinrich Rohrer received the Nobel prize in physics for the development of the scanning tunneling microscope, more and more sophisticated methods have been developed which provide the insight into the nanocosmos we are interested in.

DR. STEFAN LACH
TUTOR, DEPARTMENT OF PHYSICS,
TU KAISERSLAUTERN

As a campus university with around 14,700 students, the TUK offers approx. 100 future-oriented degree programmes in twelve departments. The manageable size of the university also guarantees students close contact to professors and outstanding support. The TUK has a lot to offer its students, including a multitude of attractive degree programmes such as biophysics, biological or chemical engineering, food chemistry and engineering mathematics. Most degree programmes are interdisciplinary in nature and therefore unite various disciplines. A degree in a STEM subject (science, technology, engineering, mathematics) opens interesting and diverse career prospects.

The TUK enjoys an excellent international reputation in research and teaching. Students and (junior) scientists benefit from the numerous internationally renowned research institutions that cooperate closely with the TUK in the field of applied research. These include, amongst others, two Fraunhofer institutes, one Max Planck institute, the German Research Centre for Artificial Intelligence, and the Institute for Composite Materials.

KAISERSLAUTERN, AS A CENTRE FOR SCIENCE, IS ONE OF THE MOST SIGNIFICANT IT CLUSTERS IN EUROPE

The TUK is a member in the group “Universität der Großregion - UniGR” (University of the Greater Region). The other members are the universities in Lorraine, Liège, Luxembourg, Saarbrücken, and Trier. This means that TUK students can also benefit from, e.g., the range of courses offered at the partner universities. Further information: www.uni-kl.de/uni-gr

Students will also benefit from an appealing housing situation: There are more than 2,000 student rooms available in close proximity to the campus. All rooms naturally come with free internet. The Department of International Affairs/ISGS offers international students and scientists a broad range of support services to help them get settled at the TUK as quickly as possible. Junior scientists (e.g., doctoral candidates) are supported in their personal and professional development by the TU-Nachwuchsring (network for support of young scientists).

THE CAMPUS OF THE TUK ALSO HAS A LOT TO OFFER IN ADDITION TO PROFESSIONAL TRAINING

Thanks to the broad range of different sports and the variety of attractive excursions, the university’s sports programme has become a key component of recreational activities at the TUK. In the evening, students can attend concerts, the theatre, our cinema and various exhibitions on-campus. Furthermore, there are numerous student-led groups dedicated to most hobbies. The TUK’s event calendar also includes a variety of festivities, such as the summer ball or the summer party.

www.uni-kl.de

www.uni-kl.de
DO YOU HAVE ANY QUESTIONS?

CONTACT US. WE ARE HERE TO HELP.

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Subject to change and errors.

For more information on the distance learning Master's programme "Nanotechnology", as well as the distance learning Certificate programme "Nanobiotechnology" please go to: www.zfuw.de

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