Master of Biomedical Computing
Survival Guide 2017

Computer Aided Medical Procedures (CAMP)
Technische Universität München
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Welcome

Welcome to the Biomedical Computing Masters (BMC) program. This booklet is meant to help you getting started with your studies and in the program. We recommend you read it thoroughly as you will eventually need it. Here you can find information about your study plan, the study regulations, helpful contacts, and much more information. Throughout the booklet you will find a list of helpful online resources that are summarized in the final section. In case of questions not covered in this booklet, kindly contact the BMC study advisor team at CAMP. This Masters Program is still in its nascent stage, hence if you find some valuable information missing or anything that would be useful for other students, please let us know so we can make necessary changes for the future students of BMC.

Your BMC Team
2 BMC in a Nutshell

Biomedical Computing is a Master program, which aims at a specialized education in the area of medical image computing and computer assisted interventions. Therefore, you are required to attend courses (hereafter called modules) from a broad range, including:

- informatics,
- medicine,
- imaging,
- mathematical methods and scientific computing,
- programming and software engineering,
- image processing, computer vision, and pattern recognition,
- computer graphics, augmented reality and visualization, and
- additional courses that complete your studies in a more general way, e.g. language courses.

The BMC program is composed of a core set of required modules, whose attendance is mandatory to successfully complete your studies, and a large choice of elective modules, which you can pick from the lists provided in the study regulations\(^1\) (cf. [1]) or from the last pages of this booklet.

2.1 How to set up your schedule

First of all, you should be aware that with every module you allocate a certain number of ECTS credits\(^2\). The amount of credits are directly associated to the amount of work necessary for completing the module successfully. As a rule of thumb, your semester workload should not be more than 30 ECTS credits.

There is a fixed schedule for the required modules, we recommend you to follow:

**Semester 1**

- Computer Aided Medical Procedures I (6 ECTS),

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\(^1\)http://www.in.tum.de/en/fuer-studierende/master-studienangege/biomedical-computing/examination-regulations.html

\(^2\)ECTS - European Credit Transfer and Accumulation System.
2.1 How to set up your schedule

- Medical Instrumentation and Computer Aided Surgery (6 ECTS, 3 (cf. [34])),

Semester 2
- Computer Aided Medical Procedures II (5 ECTS),
- Medical Imaging Technology (4 ECTS),

Semester 3
- Master Seminar (4 ECTS),
- Medical Information Processing and Pathophysiology (6 ECTS),

Semester 4
- Master Thesis (30 ECTS)

In the first semester, these courses sum up to 12 ECTS, resulting in around remaining 18 ECTS credits for elective modules. An exemplary schedule for the first semester is shown in figure 2. You can also use TUMOnline to find more elective courses: Use Search → "Degree programs" and enter "Biomedical Computing" to find the full curriculum of currently offered courses as shown in figure 3.

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3 https://www.miti.med.tum.de/index.php?id=131&L=0
2.1 How to set up your schedule

<table>
<thead>
<tr>
<th>Compulsory Modules</th>
<th>43 Credits</th>
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</thead>
<tbody>
<tr>
<td>Informatics</td>
<td>26 Credits</td>
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<td>Medicine</td>
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<table>
<thead>
<tr>
<th>Elective Modules</th>
<th>49 Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging</td>
<td>5 or more Credits</td>
</tr>
<tr>
<td>Mathematical Methods and Scientific Computing</td>
<td>5 or more Credits</td>
</tr>
<tr>
<td>Programming and Software Engineering</td>
<td>5 or more Credits</td>
</tr>
<tr>
<td>Image Processing, Computer Vision and Pattern Recognition</td>
<td>8 or more Credits</td>
</tr>
<tr>
<td>Computer Graphics, Augmented Reality and Visualization</td>
<td>6 or more Credits</td>
</tr>
<tr>
<td>Soft Skills</td>
<td>3 or more Credits</td>
</tr>
</tbody>
</table>

| Master’s Thesis in Biomedical Computing | 30 Credits |

Figure 1: BMC modules: minimum number of credits required to be fulfilled in each area.
3 Study Regulations

It is essential to know the General Academic and Examination Regulations - ASPO\(^4\)\(^5\) (cf. [3]) and the Academic and Examination Regulations for the Master Program Biomedical Computing-FPSO\(^6\)\(^7\) (cf. [4]) very well! Some important definitions and details are listed below, but please keep in mind that the provided information is neither complete, nor legally binding!

### 3.1 Modules

Studies are organized into modules. A module consists of one or several thematically linked and synchronized courses. However, most modules con-

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\(^4\)In German, ASPO stands for Allgemeine Prüfungs- und Studienordnung
\(^5\)https://www.in.tum.de/fileadmin/user_upload/Studiengaenge/MSc_BMC/APSO-Okt2013-E.pdf
\(^6\)In German, FPSO stands for Fachprüfungs- und Studienordnung.
\(^7\)http://www.in.tum.de/fuer-studierende/master-studiengaenge/biomedical-computing/examination-regulations.html
Figure 3: TUMOnline overview for all currently available courses approved for the BMC program.
sist of only one lecture (plus optional exercises), a lab course, or a seminar. Every Bachelor or Master program is composed of required modules and elective modules:

- **Required modules** must be taken by all students and the pertinent examinations must be successfully completed.

- For **elective modules** students may choose modules in compliance with the selection and number of credits defined in the corresponding FPSO. Failed examinations in an elective module may be replaced by an examination that was passed in a different elective module within the relevant standard period of study.

As a rule, a module is completed with a written or oral module examination taken along with the coursework. The module examination may consist of an examination, coursework, or a combination of an examination and one or more coursework assignments. In addition to this module examination assignments or mid-term papers may be required during the semester. Details, in particular number, type and content of the examinations and their weighting for the module grade, are determined by the examiners in coordination with the Examination Board and shall be announced to the students in due form no later than four weeks before the beginning of classes of the respective term.

### 3.2 ECTS

The number of courses and examinations to be completed is calculated on the basis of student workload for a given module measured in credits and the accumulation of credits pursuant to the European Credit Transfer System (ECTS). The award of credits requires the **successful completion of modules**. Credits cannot be awarded for mere attendance, they require successful proof of completion of a module examination. Credits are a quantitative measurement of a student’s total workload. One credit reflects a workload of 30 hours. As a general rule students are expected to accumulate 30 credits per semester.

### 3.3 Credits and Modules

Credits for modules must be whole numbers. Modules may comprise 2 to 10 credits. In justified exceptional cases modules may comprise up to 20 credits provided that the module extends over one academic year. Further, a higher number of credits is permitted only for modules which comprise preparation
of a final thesis or which require especial practical developments or reports. 30 credits are allocated to the preparation of the Master’s Thesis.

3.4 Examinations

Various types of examinations are possible; i.e. written examinations, other written reports and oral examinations. For group examinations, the contribution an individual student has made to a group examination must be clearly discernible and assessable.

Important items for **written examinations**:

- Students who participate in a written examination must, upon request, prove their identity by presenting the student card together with a photo ID.

- If students arrive late for an examination no extra time will be allowed to compensate for time lost.

- Students may not leave the examination room without permission of the proctor. Time and duration of the absence will be recorded on the examination paper.

- Resources (like books, sheet with notes, et cetera) permitted for an examination will be determined by the examiner; they will be announced no later than four weeks before the examination date.

- Written examinations will last at least 60 and not more than 180 minutes. Modules for which more than 10 credits are awarded may require 240 minutes. The time duration of the written examination must be provided in the FPSO.

- If only a few students have registered for an examination, the lecturer in charge of the course may make a written announcement no later than four weeks before the scheduled date of the examination, that instead of a written examination an oral examination will be held.

Important items for **oral examinations**:

- Oral examinations must be administered by at least one examiner and one competent observer.

- Oral individual examinations will last at least 20 minutes and not more than 60 minutes. Oral group examinations will last at least 15 minutes and not more than 45 minutes for each candidate.
3.5 Time Limits and Progress Monitoring

- Essential elements of each subject examination shall be recorded in the minutes by competent staff.

For ALL examinations you need to register via TUM-Online\(^8\)(cf. [5]). Please note that you have to register twice for each course!!!: first for the enrollment to the course, and second but most important, for the examination. This is the only way to officially get your grade updated into the system. This applies even for courses that do not have a formal examination (e.g. lab courses and seminars).

\(^8\)https://campus.tum.de/tumonline/webnav.ini

3.5 Time Limits and Progress Monitoring

Examinations should be completed in time to achieve the number of credits stipulated in the FPSO by the end of the **standard period of study** (four semesters). For compliance with the standard length of the studies, students should follow courses summing up 30 credits per semester.

In compliance with the pertinent provisions, it is expected that students, obtain a minimum of 20 credits per semester. Students whose semester workload falls below 15 credits get a warning. Students will be appropriately informed of further details by the Faculty; in particular, the FPSO may provide that concerned students will be invited to a counseling interview.

To meet the standard period of studies, and in accordance to the FPSO:

1. At least one required module examination must be taken by the end of the second semester.

2. A minimum of 30 credits should be obtained by the end of the third semester;

3. A minimum of 60 credits should be obtained by the end of the fourth semester;

4. A minimum of 90 credits should be obtained by the end of the fifth semester;

5. A minimum of 120 credits should be obtained by the end of the sixth semester.

If requirements 1-4 are violated, in the sense that students exceed the time limits, the module examinations not yet taken are deemed taken and irreversibly failed unless justified by good cause (see ASPO §11, (7)). If 5 is
violated all module examinations not yet taken are deemed taken and not passed. In the event that students exceed the time limit by an additional semester the module examinations not yet taken are deemed irreversibly failed unless justified by good cause.

3.6 Passing or Failure of Examinations

A module is deemed passed when the module examination has been graded at least "sufficient" (4.0). If the module examination also requires coursework, this coursework must have been graded "Successful" in order to pass the module.

In order to get your BMC Master degree, you need both to pass all the required modules in the FPSO and to collect the stipulated number of required credits. In the following conditions the degree is considered as failed:

1. If a required module or required elective module has been irreversibly failed due to non-compliance with the time limit;

2. If the required number of credits in elective modules can no longer be obtained due to non-compliance with the time limit;

3. If an examination cycle, to the extent provided in the FPSO, has been irreversibly failed;

4. If the second attempt at passing the final thesis/final colloquium was not successful.

3.7 Repeat Examinations

If a module examination in a required module is failed, the module examination must be repeated. The repeat examination must, as a rule, be taken within six months from notification of the examination results. In the event of non-compliance with the aforementioned provision, the repeat examination is deemed taken and not passed. Examinations in required modules must be passed.

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9In the German grading system a 1 to 5 scale is used:
1.0-1.3 sehr gut (very good: an outstanding achievement)
1.7-2.3 gut (good: an achievement, which lies substantially above average requirements)
2.7-3.3 befriedigend (satisfactory: an achievement, which corresponds to average requirements)
3.7-4.0 ausreichend (sufficient: an achievement, which still meets the requirements)
4.3-5.0 nicht ausreichend / nicht bestanden (not sufficient / failed: an achievement, which does not meet the requirements)
For each module examination at least one repeat examination will be offered. Passed examinations may not be repeated for the purpose of improving grades. In general a repeat examination for failed examinations in required and required elective modules is to be offered every semester.

Examinations in an elective module that were not passed may be repeated. Failed examinations in an elective module may also be replaced by an examination that was passed in a different elective module. The final thesis and the final colloquium may be repeated only once. Students who have failed examinations administered by the Technische Universität München may repeat those examinations only at the Technische Universität München.
4 Frequently Asked Questions

1. **What is the total number of ECTS credits required per semester?**
   You have to obtain at least 120 credits in the 4 semesters. 30 are reserved for your Master’s Thesis, so for each of the 3 other semesters you need about 30 credits. You are free to distribute the courses to take over your study time, as discussed and decided with your studies advisor.

2. **What is the difference between “required modules” and “elective modules”?**
   The required modules are counted in your ECTS records, no matter what grade you get in your final exam. The results of elective courses can still, after you have participated in the exam, be discarded if the student is not satisfied with their result.

3. **Is it possible to take German language classes?**
   Our university offers a large choice of German classes, which you can find in the TUM Language Center\(^\text{10}\)(cf. [6]). There is typically no fee for these language courses. However, language courses are an additional offer to your education and they are not part of our study program. You are encouraged to attend a German language course, but you will not be credited within our Master’s program.

4. **Are there alternatives to lectures taught in German language?**
   In the study plan there are enough courses offered in English to fulfill all ECTS requirements and still have a broad choice for different lectures.

5. **Is it possible to repeat passed exams to improve the grade?**
   No, passed exams cannot be repeated. However, failed examinations in an elective module may also be replaced by an examination that was passed in a different elective module.

6. **Who can help with English assignments?**
   In the English Writing Center\(^\text{11}\)(cf. [7]) (Munich City Campus, Arcisstr. 19, Room 001) you can get help with writing tasks in English: homework assignments, CV, motivation letter, presentation, or section of a thesis or dissertation. You can make an appointment through the

\(^{10}\)http://www.sprachenzentrum.tum.de/en

\(^{11}\)http://www.sprachenzentrum.tum.de/en/academic-english-cluster/english-writing-center
online booking calendar. Walk-in appointments are also be accepted if time is available. Also open during semester breaks!
5 Contacts

5.1 CAMP

There are several study advisors for Biomedical Computing at CAMP. If you have questions specific to this program or your course of study, contact them first. Study advisors for the program can be reached via email: bmc-coordination@mailnavab.in.tum.de

5.2 Servicebüro Informatik - Studium

For almost all administrative questions the best point to start is the “Student Info Point” (room MI 00.10.013)\(^{12}\)(cf. [26]). Among other things, they can help you with examination procedures, computer access and other issues revolving around the course of study. If any question falls outside their scope, they can redirect you to the appropriate contact person.

The “International Office” \(^{13}\)(cf. [8]) hosts a very informative webpage where you can find answers to almost all questions regarding settling down in Munich and other international affairs. You can find more Informatics related information on the Department homepage for international degree students \(^{14}\)(cf. [?]). The person in charge here is Christine Müller christine.mueller@in.tum.de).

The academic advisors (Dr. Angelika Reiser and Vivija Simić)\(^{15}\)(cf. [9]) can help you with general questions about studying computer science at TUM.

5.3 Student Society

Last, but not least, at the student society(room MI 00.06.036) you can meet other students – they do not necessarily study the same program or even subject as you do, but they are students as well and might know your problems from their own experience.

\(^{12}\)http://www.in.tum.de/en/current-students/services-facilities-it/infopoint.html
\(^{13}\)http://www.international.tum.de/en/home/
\(^{14}\)https://www.in.tum.de/en/international-affairs/international-degree-students.html
\(^{15}\)http://www3.in.tum.de/~reiser/
6 Computing Resources

A computer science department account should already have been created for you. You can collect your account details from the “Student info point” (see section 5) with your student ID and a second ID with photo, e.g. your passport. There is an email address with both domains, @in.tum.de and @cs.tum.edu, associated with the account. This address is activated after you log in at the computer hall for the first time. It is possible to access your emails using a webmail client\(^{16}\)(cf. [11]).

With your account from the computer science department, you can use the computers in the computer hall of the mathematics / computer science building. You can also use the scanner and laser printer there; pre-paid quotas for these services are available from the student society. There are more computers available in the library, and for practical courses there are usually computers available in a student lab at the respective chair. The computer science department has bought access to a wide range of Microsoft products for students (no Office, no games, though), which can be accessed via the studiSoft framework\(^{17}\)(cf. [12]).

If you want to use your own laptop, there is a wireless connection available practically everywhere inside the buildings. In the mathematics / computer science building there is the network “FMI”\(^{18}\)(cf. [13]) (either proxy or LRZ VPN client needed), in most other buildings there is the network “lrz” available (LRZ VPN client needed). More information about the computer science department computing resources\(^{19}\)(cf. [14]), the LRZ VPN client\(^{20}\)(cf. [15]) and the eduroam network\(^{21}\)(cf. [16]) can be found online.

For some applications you might need a digital certificate. Those are pre-computed and stored encrypted in your computer science department account. If you need to use the certificate, you can get the password at the “Student info point” (see section 5).

\(^{16}\)https://mail.tum.de
\(^{17}\)https://www.studisoft.de/shibboleth/shibdwayf
\(^{18}\)https://www.in.tum.de/rbg/it-dienste/netzzugang/wlan.html
\(^{19}\)https://www.in.tum.de/rbg.html
\(^{20}\)https://www.lrz.de/services/netz/mobil/vpn.en
\(^{21}\)https://www.lrz.de/services/netz/mobil/eduroam/
7 Locations

There are different locations which might be relevant for you during your studies:

- Garching Campus
- City campus ("Stammgelände") in the city center, near Königsplatz
- Klinikum rechts der Isar, near Max-Weber-Platz, where the **IFL lab** (Interdisziplinäres Forschungslabor) is located.
- Innenstadtklinikum, near Sendlinger Tor, where the **NARVIS lab** is located.
- Klinikum Großhadern

You can find more information about the labs at the online room list\(^\text{22}\) (cf. [17]). You may also find useful the online TUM Room Finder\(^\text{23}\) (cf. [18]). In the following we briefly describe the campus in Garching and the “Klinikum rechts der Isar” hospital below.

7.1 Garching

Here are some maps of the Mathematics/Computer Science building (see figure 5) and the campus Garching (see figure 4).

Room numbers in the Mathematics resp. Computer Science department are built as “Level.Part.Room”, i.e. the room “MI 03.13.010” (our seminar room) is on level three, in building part 13, and there it is room number ten.

On the campus Garching, there are several **possibilities to have lunch:**

- Directly in the mathematics / computer science building there is the **FMI Bistro\(^\text{24}\)** (cf. [19]), usually offering three or four dishes between 2.85 and 6.20 Euros.
- In the **Mensa\(^\text{25}\)** (cf. [20]) you can usually choose between three dishes ranging from 1.00 to 3.40 Euros.

\(^\text{22}\)http://campar.in.tum.de/Chair/RoomList \(^\text{23}\)http://portal.mytum.de/campus/index_html/roomfinder
\(^\text{24}\)https://www.in.tum.de/rbg/beschaffung/sonstige-dienste/speiseplaene-fmi-bistro.html
\(^\text{25}\)http://www.studentenwerk-muenchen.de/mensa/speiseplan/index-de.html
Figure 4: Map of the Garching Campus.
Figure 5: Mathematics-/Informatics building. CAMP is located in MI 03.13, the “Student info point” is at MI 00.10.013, the student society is at MI 00.06.036.
• There are two cafeterias, one directly above the Mensa and one in the mechanical engineering department, offering three to four dishes priced from 2.00 Euros.

At the FMI Bistro you can only pay cash, at the Mensa you can only pay with your student card, at the cafeterias you can use both. In order to pay with your student card, you have to charge the card with money at one of several machines in the Mensa or next to the cafeterias.

There are several libraries in the Garching Campus, the two most interesting for you are those in the mechanical engineering department and in the mathematics / computer science building. The former has mostly textbooks, the latter has more specialized titles. In any case, you can use the OPAC online system\(^26\)(cf. [21]) to check if the document you look for is available in any of the libraries.

\(^{26}\text{https://opac.ub.tum.de/}\)
7.2 Klinikum rechts der Isar

The hospital “Klinikum rechts der Isar” is next to the subway station “Max-Weber-Platz”. Don’t get confused with the main entry in Ismaninger Straße (it is easy to get lost in the maze of corridors spanning the hospital!), the lecture halls (A to D, cf. figure 6), “Hörsaal Pavillon” (cf. figure 7) and IFL can best be reached from Einsteinstraße. The mensa offers a choice of two menus for 3.20 Euros each or a special dish for around 3.00 Euros.

Hörsaal Pavillon: The “Hörsaal Pavillon” can best be reached from the eastern exit of the subway. It is on the ground level of building 551. From the outside you can already see the pavillon, and you can enter the glass hallway from inside the lecture halls building (cf. figure 7).

ME CIP Chirurgie: The “ME CIP Chirurgie” is the lab of the Minimally Invasive Therapeutic Interventions (MITI) group. Next to the eastern subway exit (cf. figure 6) there is a pedestrian gate in the fence, so walk through it. Around the corner, walk down the ramp, enter the building through the roller door. You are now in the basement below the emergency department. Ten meters inside the building, there’s a crossing, turn right/north here. After approx. 20 meters there’s a downward slope, at the bottom of the slope there’s a door on the right, labelled “MITI”.
Figure 6: Hospital “Klinikum rechts der Isar”. “A” to “D” are the lecture halls and the IFL is located in the lowest level of building 501, the mensa is in the lowest level of building 551. The “Hörsaal Pavillon” is on the ground level of building 551.
Figure 7: The “Hörsaal Pavillon” is on the ground level of building 551. From the outside you can already see the pavillon (upper picture), and you can enter the glass hallway from inside the lecture halls building (lower picture).
8 Helpful Links

Here you find a list of pointers to helpful resources, mainly online.

[1] Academic and Examination Regulations for BMC.
   http://www.in.tum.de/en/fuer-studierende/
   master-studiengaenge/biomedical-computing/
   examination-regulations.html

   http://www.in.tum.de/en/current-students/masters-programs/
   biomedical-computing/curriculum.html

   https://www.in.tum.de/fileadmin/user_upload/Studiengaenge/
   MSc_BMC/APS0-Okt2013-E.pdf

[4] Academic and Examination Regulations for the Master Program
   Biomedical Computing (German)
   http://www.in.tum.de/fuer-studierende/master-studiengaenge/
   biomedical-computing/examination-regulations.html.

[5] TUMonline: portal for lectures, examinations, grades etc.
   https://campus.tum.de/tumonline/webnav.ini

   http://www.sprachenzentrum.tum.de/en

   http://www.sprachenzentrum.tum.de/en/
   academic-english-cluster/english-writing-center

[8] International office.
   http://www.international.tum.de/en/home/

   http://www3.in.tum.de/~reiser/

    http://www.mpi.fs.tum.de/

    https://mail.tum.de
[12] Microsoft and other software provided for students.
   https://www.studisoft.de/shibboleth/shibdwayf

   https://www.in.tum.de/rbg/it-dienste/netzzugang/wlan.html

[14] Computing infrastructure at the computer science department.
   https://www.in.tum.de/rbg.html

   https://www.lrz.de/services/netz/mobil/vpn_en

[16] Eduroam: Roaming internet access available in many universities in
   Europe and world-wide.
   https://www.lrz.de/services/netz/mobil/eduroam/

[17] CAMP Labs & Locations.
   http://campar.in.tum.de/Chair/RoomList

[18] TUM Room finder.
   http://portal.mytum.de/campus/index_html/roomfinder

   https://www.in.tum.de/rbg/beschaffung/sonstige-dienste/
   speiseplaene-fmi-bistro.html

   http://www.studentenwerk-muenchen.de/mensa/speiseplan/
   index-de.html

[21] Online catalogue of the TUM university library.
   https://opac.ub.tum.de/

[22] Biomedical Computing Portal.
   http://campar.in.tum.de/Students/BiomedicalComputing

   http://campar.in.tum.de/WebHome

[24] Campus Cneipe: a pub within the Garching Campus.
   http://www.c2.tum.de/

   http://campar.in.tum.de/Chair/IFL
[26] Student Infopoint.
 http://www.in.tum.de/en/current-students/services-facilities-it/infopoint.html

 http://portal.mytum.de/navigation_view

[28] NARVIS lab.
 http://campar.in.tum.de/Chair/NarvisLab

[29] TUM semester dates and holidays.

[30] TU-Film: cinema by students for students.
 http://www.tu-film.de/

[31] TUM university libraries.
 http://www.ub.tum.de/

[32] TUM Faculty of Informatics.
 http://www.in.tum.de/en.html

[33] Zentraler Hochschulsport München (University Sports Central): sports for students.
 http://www.zhs-muenchen.de/

[34] Lecture ”Medical Instrumentation and Computer Aided Surgery” (MICS): Mandatory lecture at the Klinikum rechts der Isar.
 https://www.miti.med.tum.de/index.php?id=131&L=0
Compulsory Modules Computer Science
A total of 25 credits are to be effected in the following compulsory modules:

<table>
<thead>
<tr>
<th>ID.</th>
<th>Module description</th>
<th>Type</th>
<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN2021</td>
<td>Computer Aided Medical Procedures</td>
<td>4L</td>
<td>WS</td>
<td>6</td>
<td>English</td>
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<tr>
<td>IN2022</td>
<td>Computer Aided Medical Procedures II</td>
<td>2L+2E</td>
<td>SS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN2107</td>
<td>Master Seminar</td>
<td>2S</td>
<td>WS/SS</td>
<td>4</td>
<td>German/English</td>
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<tr>
<td>IN4136</td>
<td>Clinical Internship</td>
<td>6P</td>
<td>WS</td>
<td>10</td>
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Compulsory Modules Medicine
A total of 16 credits are to be effected in the following compulsory modules:

<table>
<thead>
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<th>Module description</th>
<th>Type</th>
<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME156</td>
<td>Medical Instrumentation and Computer Aided Surgery</td>
<td>4L</td>
<td>WS</td>
<td>6</td>
<td>English</td>
</tr>
<tr>
<td>ME156</td>
<td>Medical Imaging Technology</td>
<td>2P</td>
<td>SS</td>
<td>4</td>
<td>English</td>
</tr>
<tr>
<td>ME156</td>
<td>Medical Information Processing and Pathophysiology</td>
<td>4L</td>
<td>WS</td>
<td>6</td>
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Elective Modules Imaging
A minimum of 7 credits are to be effected in the following elective modules:

<table>
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<tr>
<th>ID.</th>
<th>Module description</th>
<th>Type</th>
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<th>ECTS</th>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td>IN2273</td>
<td>Interventional Imaging and Image Processing</td>
<td>2L</td>
<td>WS</td>
<td>3</td>
<td>English</td>
</tr>
<tr>
<td>IN2286</td>
<td>Image Guided Surgeries</td>
<td>2L+2E</td>
<td>SS/WS</td>
<td>6</td>
<td>English</td>
</tr>
<tr>
<td>PH2001</td>
<td>Biomedizinische Physik 1</td>
<td>2L</td>
<td>WS</td>
<td>5</td>
<td>German</td>
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<tr>
<td>PH2002</td>
<td>Biomedizinische Physik 2</td>
<td>2L</td>
<td>SS</td>
<td>5</td>
<td>German</td>
</tr>
<tr>
<td>EI3999</td>
<td>Introduction to Biological Imaging</td>
<td>2L+2E</td>
<td>WS</td>
<td>6</td>
<td>English</td>
</tr>
<tr>
<td>ME030</td>
<td>Case Studies on Modern Imaging</td>
<td>2L+2E</td>
<td>SS</td>
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<td>English</td>
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</tbody>
</table>

Elective Modules Mathematical Methods and Scientific Computing
A minimum of 8 credits are to be effected in the following elective modules:

<table>
<thead>
<tr>
<th>ID.</th>
<th>Module description</th>
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<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN2001</td>
<td>Algorithms of Scientific Computing</td>
<td>4L+2E</td>
<td>SS</td>
<td>8</td>
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</tr>
<tr>
<td>IN2002</td>
<td>Algorithms of Scientific Computing II</td>
<td>2L+1E</td>
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<td>English</td>
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<tr>
<td>ID</td>
<td>Module description</td>
<td>Type</td>
<td>Sem</td>
<td>ECTS</td>
<td>Language</td>
</tr>
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</tr>
<tr>
<td>IN2005</td>
<td>Scientific Computing I</td>
<td>2L+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2124</td>
<td>Basic Mathematical Tools for Imaging and Visualization</td>
<td>2L+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2141</td>
<td>Scientific Computing II</td>
<td>2L+2E</td>
<td>SS</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2156</td>
<td>Numerical Programming</td>
<td>4L+2E</td>
<td>WS</td>
<td>8</td>
<td>English</td>
</tr>
<tr>
<td>IN2012</td>
<td>Parallel Numerics</td>
<td>2L+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN3400</td>
<td>Selected Topics in the Area of Algorithms and Scientific Computing</td>
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**Elective Modules Programming and Software Engineering**

A minimum of 3 credits are to be effected in the following elective modules:

<table>
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<th>Module description</th>
<th>Type</th>
<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN1503</td>
<td>Advanced Programming</td>
<td>2L+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN2003</td>
<td>Effiziente Algorithmen und Datenstrukturen</td>
<td>4L+2E</td>
<td>WS</td>
<td>8</td>
<td>English</td>
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<tr>
<td>IN2081</td>
<td>Muster in der Softwaretechnik</td>
<td>2V+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN2126</td>
<td>Software Engineering I</td>
<td>3L+2E</td>
<td>WS</td>
<td>6</td>
<td>German/English</td>
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<tr>
<td>IN2147</td>
<td>Parallele Programmierung</td>
<td>2L+2E</td>
<td>SS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN4102</td>
<td>Praktikum GPU Programming in Computer Vision</td>
<td>6P</td>
<td>WS</td>
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<td>German/English</td>
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<tr>
<td>IN2106</td>
<td>iOS Praktikum</td>
<td>6P</td>
<td>SS</td>
<td>10</td>
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<td>IN3050</td>
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**Elective Modules Image Processing, Computer Vision and Pattern Recognition**

A minimum of 9 credits are to be effected in the following elective modules:

<table>
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<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td>IN2023</td>
<td>Bildverstehen I: Methoden der industriellen Bildverarbeitung</td>
<td>2L</td>
<td>SS</td>
<td>3</td>
<td>German</td>
</tr>
<tr>
<td>IN2057</td>
<td>3D Computer Vision</td>
<td>2L+2E</td>
<td>SS</td>
<td>5</td>
<td>English</td>
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<tr>
<td>IN2061</td>
<td>Einführung in die digitale Signalverarbeitung</td>
<td>3L+3E</td>
<td>SS</td>
<td>7</td>
<td>English</td>
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<tr>
<td>IN2064</td>
<td>Maschine Learning</td>
<td>4L+2E</td>
<td>WS</td>
<td>8</td>
<td>English</td>
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<tr>
<td>IN2065</td>
<td>Maschine Learning II</td>
<td>3L</td>
<td>-</td>
<td>4</td>
<td>German</td>
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<tr>
<td>IN2123</td>
<td>3D Computer Vision II</td>
<td>2L+2E</td>
<td>WS</td>
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<td>English</td>
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</table>
### Elective Modules

**Computer Graphics, Augmented Reality and Visualization**
A minimum of 4 credits are to be effected in the following elective modules:

<table>
<thead>
<tr>
<th>ID</th>
<th>Module description</th>
<th>Type</th>
<th>Sem</th>
<th>ECTS</th>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td>IN2015</td>
<td>Image Synthesis</td>
<td>3L</td>
<td>WS</td>
<td>4</td>
<td>German</td>
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<tr>
<td>IN2023</td>
<td>Bildverstehen I: Methoden der industriellen Bildverarbeitung</td>
<td>2L</td>
<td>SS</td>
<td>3</td>
<td>German</td>
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<tr>
<td>IN2016</td>
<td>Bildverstehen II: Robot Vision</td>
<td>3L</td>
<td>WS</td>
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<tr>
<td>IN2018</td>
<td>Augmented Reality</td>
<td>2L+2E</td>
<td>WS</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2020</td>
<td>Geometrierei-arbeitung</td>
<td>3L</td>
<td>unre-gelm.</td>
<td>4</td>
<td>German</td>
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<tr>
<td>IN2025</td>
<td>Simulation und Animation</td>
<td>3L</td>
<td>SS</td>
<td>4</td>
<td>German</td>
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<tr>
<td>IN2026</td>
<td>Scientific Visualization</td>
<td>3L</td>
<td>WS</td>
<td>4</td>
<td>English</td>
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<tr>
<td>IN2024</td>
<td>Modellbasierte Auswertung von Bildern und Bildfolgen</td>
<td>2L</td>
<td>SS</td>
<td>3</td>
<td>German/English</td>
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<tr>
<td>IN2067</td>
<td>Robotik</td>
<td>3L+2E</td>
<td>WS</td>
<td>6</td>
<td>English</td>
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<tr>
<td>IN2111</td>
<td>Dreidimensionale Nutzerschnittstellen</td>
<td>2L+2E</td>
<td>SS</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2112</td>
<td>2D grafische Nutzerschnittstellen für Desktop-basierte und mobile Computeranwendungen</td>
<td>2L+2E</td>
<td>unre-gelm.</td>
<td>5</td>
<td>English</td>
</tr>
<tr>
<td>IN2124</td>
<td>Grundlegende Mathematische</td>
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<td>5</td>
<td>English</td>
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<tr>
<td>ID.</td>
<td>Module description</td>
<td>Type</td>
<td>Sem</td>
<td>ECTS</td>
<td>Language</td>
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<tr>
<td>IN2163</td>
<td>Informations-systeme im Gesundheits-wesen</td>
<td>2L</td>
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<td>3</td>
<td>German</td>
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<tr>
<td>IN9038</td>
<td>Medical Imaging Entrepreneurship</td>
<td>2L</td>
<td>WS/ SS</td>
<td>4</td>
<td>English</td>
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<tr>
<td>SZ0406</td>
<td>English - Writing Academic Research Papers C2</td>
<td>2S</td>
<td>WS</td>
<td>4</td>
<td>English</td>
</tr>
</tbody>
</table>

In addition to these, students are welcome to effect credits in soft skills events offered by the Carl-von-Linde Akademie.

**Description:**
Sem. = Semester, WS = Winter term, SS = Summer term; SWS = hours per semester week; L = Lecture; E = Exercise; S = Seminar; P = Practical Course

Each module can only be accounted within one of the module groups.