

Examination and Academic Regulations for the Master's Program in Biomedical Computing at the Technische Universität München.

(The German version of October 25, 2018)

25 October 2018

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In accordance with Art. 13 (1) sentence 2 in conjunction with Art. 58 (1) sentence 1, Art. 61 (2) sentence 1 and Art. 43 (5) of the Bayerisches Hochschulgesetz (BayHSchG) [Bavarian Higher Education Act] the Technische Universität München issues the following Examination and Academic Regulations (*Fachprüfungs- und Studienordnung, FPSO*):

Introductory note on linguistic usage

In accordance with Art. 3 (2) of the German Constitution, women and men have equal rights. Any terms relating to persons and functions mentioned in the following regulations are equally valid for women and men.

The English version is provided merely as a convenience and is not intended to be a legally binding document.

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Applicability, Academic Titles

- (1) ¹These Examination and Academic Regulations for the Master's program in Biomedical Computing (FPSO) complement the General Academic and Examination Regulations for Bachelor's and Master's programs at the Technische Universität München (APSO) from March 18, 2011 as amended. ²The APSO shall have precedence.
- (2) ¹Upon successful completion of the Master's examination the degree "Master of Science" ("M.Sc.") is awarded. ²The academic title may also be used with the name of the university "(TUM)".

§ 35

Commencement of Studies, Standard Duration of Study, ECTS

- (1) Commencement of the Master's program in Biomedical Computing at the Technische Universität München is possible in the winter semester.
- (2) ¹The number of classes in required and elective subjects needed to obtain the Master's degree is 90 credits spread over three semesters. ²Furthermore, a maximum of six months (30 credits) is added for the completion of the Master's thesis pursuant to § 46. ³The number of examinations in required and elective subjects to be completed in the Biomedical Computing Master's program according to Appendix 1 is a minimum of 120 credits. ⁴The standard duration of study for the Master's program will be a total of four semesters.

§ 36

Eligibility Requirements

- (1) Eligibility for the Master's program in Biomedical Computing is demonstrated by
 1. a qualified Bachelor's degree obtained in at least six semesters at a domestic or foreign university or an at least equivalent degree in Informatics, Mathematics, Physics, Electrical Engineering or Mechanical Engineering or comparable programs,
 2. passing of the Aptitude Test for the Master's program Biomedical Computing pursuant to Appendix 2,
 3. applicants who obtained their first degree in one of the following countries, must demonstrate specialized knowledge through a "Graduate Record Examination (GRE) General Test" or a "Graduate Aptitude Test in Engineering" (GATE): China, Bangladesh, India, Iran, Pakistan; for applicants with a first degree from a country that is not a signatory state of the Convention on the Recognition of Qualifications concerning Higher Education in the European Region of April 11, 1997 (henceforth referred to as Lisbon Convention), a submission of the test pursuant to sentence 1 is recommended as it will be requested in case of substantial differences in regard to the competencies proven by the first degree pursuant to subsection 2; the request will not be necessary in case of degrees from the signatory states of the Lisbon Convention; details concerning the completion of the test will be announced in time on the webpages of the examination board,

4. an adequate knowledge of the English language; students whose native language or language of instruction is not English must demonstrate proficiency through an acknowledged language test (Competence level C1 according to the Common European Framework of Reference) such as “Test of English as a Foreign Language“ (TOEFL) (at least 88 points), “International English Language Testing System” (IELTS) (at least 6,5 points) or “Cambridge Main Suite of English Examinations”; if the final thesis (Bachelor’s Thesis) was written in English, an adequate knowledge of the English language is also considered proven.
- (2) A degree is considered a qualified degree within the meaning of subsection 1 if such degree requires the successful completion of examinations that are equivalent to the examinations specified in subsection 1, no. 1, and correspond to the subject-specific requirements of the Master’s program in Biomedical Computing.
- (3) ¹The assessment according to subsection 2 will be performed on the basis of the required modules of the corresponding Bachelor’s programs. ²If certain examination results are missing for the assessment, the Aptitude Test Committee pursuant to Appendix 2 no. 3 may require that the candidates demonstrate eligibility pursuant to subsection 1 by taking those examinations as additional Fundamentals Exams pursuant to Appendix 2 no. 5.1.3. ³The candidate must be informed thereof after review of the documentation during the first stage of the Aptitude Test.
- (4) The comparability of programs, the subject-specific aptitude as well as the equivalence of degrees acquired from foreign institutions will be decided upon by the examination board in compliance with Art. 63 of the Bayerisches Hochschulgesetz [Bavarian Higher Education Act].

§ 37

Modular Structure, Module Examination, Courses, Course Specialization, Language of Instruction

- (1) ¹General provisions concerning modules and courses are set forth in §§ 6 and 8 of the APSO. ²For any changes to the stipulated module provisions § 12 (8) of the APSO shall apply.
- (2) The curriculum listing the required and elective courses is included in Appendix 1.
- (3) ¹The language of instruction of the Master’s program Biomedical Computing is English. ²Courses taught in the German language may also be attended. ³In case specific modules are taught in German, this is indicated in Appendix 1. ⁴Students who did not provide a proof of proficiency in German for the application, are admitted on condition to complete at least one module providing integrative knowledge of the German language within the first two semesters of their studies. ⁵The course offer will be published by the Examination Board according to local practice. ⁶Voluntarily completed extra-curricular modules e.g. German language courses by the TUM Language Center will be recognized.

§ 38

Examination Deadlines, Progress Monitoring, Failure to Meet Deadlines

- (1) Examination deadlines, progress monitoring, and failure to meet deadlines are governed by § 10 of the APSO.
- (2) ¹At least one of the module examinations listed in Appendix 1 must be successfully completed by the end of the second semester. ²In the event of failure to meet deadlines § 10 (5) of the APSO shall apply.

§ 39

Examination Board

Pursuant to § 29 of the APSO the board responsible for all decisions concerning examination matters shall be the Examination Board of the Department of Informatics of the Technische Universität München.

§ 40

Recognition of Periods of Study, Coursework and Examination Results

The recognition of periods of study, coursework and examination results is governed by the provisions of § 16 of the APSO.

§ 41

Continuous Assessment Procedure, Forms of Examination

- (1) Pursuant to §§ 12 and 13 of the APSO valid types of examination in this program of studies are, besides written and oral exams, in particular laboratory exercises, practical exercises ("Testate", if applicable), reports, project works, presentations, learning portfolios, scientific elaborations and exam courses.
 - a) ¹A **written exam** is a supervised written test that shall prove the ability to recognize and understand problems and to find ways of their solution in a limited amount of time using specified methods and predefined auxiliaries. ²The duration of written exams is governed by § 12 (7) of the APSO. ³It shall be proven that in a limited amount of time with given methods and predefined auxiliaries problems can be recognized and understood, ways of their solution can be found and, if necessary, applied.
 - b) ¹**Laboratory exercises** are, depending on the respective discipline, experiments, measurements, fieldwork, field exercises etc. with the objective of implementation, analysis and gain of knowledge. ²Elements are for example: description of the processes and the respective theoretical foundations including study of scientific literature, preparation and implementation of experiments, if applicable necessary calculations, their documentation, evaluation and interpretation of results in regard to acquirable knowledge. ³Additionally a presentation may be part of the project in order to examine the communicative competence of presenting scientific topics to an audience. ⁴Details concerning the particular laboratory exercise and the required qualifications are listed in the module description.
 - c) ¹A **practical exercise ("Testate", if applicable)** is the practical processing of given assignments (e.g. mathematical problems, programming exercises, modeling exercises etc.) with the objective of applying theoretical contents to solve application-oriented problems. ²It serves to prove knowledge of facts and

details as well as knowledge of their application. ³The practical exercise may be conducted in written, oral or electronic form. ⁴Possible forms of examination are homework, exercise sheets, programming exercises, (electronic) tests, exercises as part of practical courses etc. ⁵Details concerning the particular practical exercise and the required qualifications are listed in the module description.

- d) ¹A **report** is a written elaboration and summary of a study process with the objective of describing the acquired knowledge in a structured way and analyzing the results in the context of a module. ²The report shall prove the ability to understand and reproduce the main aspects in a written form. ³Possible forms of reports are for example field trip reports, practical course reports, labor reports etc. ⁴Additionally a presentation may be part of the project in order to examine the communicative competence of presenting scientific topics to an audience.
- e) ¹In the course of a **project work**, a project assignment shall be completed as a defined objective within a predefined period of time and using suitable auxiliaries. This should be accomplished in several phases (initiation, problem definition, distribution of roles, idea generation, development of success criteria, decision-making, implementation, presentation, written evaluation). ²Additionally a presentation may be part of the project to examine the communicative competence of presenting scientific topics to an audience. ³The components of the project work and the required qualifications are listed in the module description. ⁴The project work may also be conducted in form of teamwork. ⁵This is intended to prove that exercises can be solved in a team. ⁶The individual contribution to be assessed as an examination achievement must be individually recognizable and assessable. ⁷The same applies to the individual contribution to the group performance.
- f) ¹A **scientific elaboration** is a written examination where a student autonomously works on a challenging scientific or respectively scientific-application-oriented problem with scientific methods of the particular discipline. ²It is intended to prove that such problem in line with the intended study results of the respective module can be tackled on a scientific basis and according to the principles of academic work – from analysis to conception to realization. ³Possible forms, differing in their aspiration level, are position paper, abstract, essay, study work, seminar paper etc. ⁴A scientific elaboration may be supported by a presentation and a colloquium to check the communicative competence regarding presenting scientific topics to an audience. ⁵In this case, also the involvement in the discussion about the work and presentation of other participants may be part of the evaluation. ⁶Detailed components of the particular scientific elaboration and the required qualifications are listed in the module description.
- g) ¹A **presentation** is a systematic, structured oral performance visually supported by suitable media (e.g. beamer, slides, posters, videos) which illustrates and summarizes specific topics or results and reduces complex issues to the essential. ²The presentation shall prove the capacity of working out a certain topic within a predefined time so that it may be presented in a clear and comprehensive way to an audience. ³Also it shall be proven that questions, suggestions and points of discussion by the audience in reference to the particular topic are handled competently. ⁴The presentation may be supported by a short written workup. ⁵The presentation may be accomplished as team or single-person work. ⁶The contribution assessed as examination must be individually recognizable and assessable. ⁷This also must hold for the particular contribution to the group performance.

- h) ¹An **oral exam** is a time-limited examination dialogue about certain topics and concrete questions to be answered. ²By oral examinations it shall be proven that the qualification objectives listed in the module descriptions are achieved, that connections between the examination subjects were recognized and that particular problems can be classified with respect to these coherences. ³The oral exam may be accomplished as individual or group examination. ⁴The duration of oral exams is governed by § 13 (2) of the APSO.
- i) ¹A **learning portfolio** is a written exposition of the student's own works selected by predefined criteria with the object of proving the learning progress and the performance level at a specific time and regarding to a defined content. ²The choice of the specific works as well as their connection to the learning progress and their informative content for achieving the qualification have to be explained. ³By a learning portfolio it shall be proven that the learning progress is handled responsibly and that the qualification objectives listed in the module descriptions are achieved. ⁴Depending on the module description, possible components of successful self-monitoring of the learning portfolio are especially application-oriented papers, websites, web blogs, bibliographies, analyses, discussion papers and graphic preparations of specific issues. ⁵Detailed components of the particular learning portfolio and the required qualifications are listed in the module description.
- j) ¹Within the **Exam Course**, several elements have to be completed within one examination. ²Contrary to a partial module examination, the examination will be conducted in an organisationally (spatially resp. temporally) connected manner. ³Examination elements are a number of different forms of examinations that in their entirety capture the overall competency profile of the module. ⁴Examination elements can also be forms of examinations pursuant to the letters a) to i). ⁵The entire duration of an examination shall be specified in the module catalogue, type of examination and duration of the individual examination elements shall be specified in the module description.
- (2) ¹The module examinations will, as a rule, be taken concurrently with the program. ²Type and duration of module examinations are provided for in Appendix 1. ³In the event of divergence from those provisions, § 12 (8) of the APSO must be complied with. ⁴The assessment of the module examination is governed by § 17 of the APSO.
- (3) Where Appendix 1 provides that a module examination is either in written or oral form, the examiner must inform the students in appropriate form, no later than the first day of classes, of the type of examination to be held.
- (4) Upon request of a student and with the agreement of the examiners, examinations may be taken in a different language than the course language.

§ 42

Registration for and Admission to the Master's Examination

- (1) Students who are enrolled in the Master's program in Biomedical Computing are deemed admitted to the module examinations of the Master's examination.
- (2) ¹Registration requirements for required and elective module examinations are stipulated in § 15 (1) of the APSO. ²The registration requirements for repeat examinations for failed required and required elective modules are stipulated in § 15 (2) of the APSO.

§ 43

Scope of the Master's Examination

- (1) The Master's examination consists of:
 1. The module examinations in the corresponding modules pursuant to subsection 2,
 2. The Master's thesis pursuant to § 46.
- (2) ¹The module examinations are listed in Appendix 1. ²A total amount of 43 credits in required modules and at least 47 credits in elective modules must be completed. ³The selection of modules must be in compliance with § 8 (2) of the APSO and Appendix 1.

§ 44

Repeat Examinations, Failed Examinations

- (1) ¹The repetition of examinations is governed by § 24 of the APSO. ²The repeat examination for a module examination administered at the end of the lecture period and not passed, as a rule must be taken not later than by the end of the first week of the lecture period of the following semester. ³In derogation of sentence 2, the date of repeat examinations of examinations which are not offered by the Department of Informatics, has to comply with the regulations of the offering department.
- (2) Failure of examinations is governed by § 23 of the APSO.

§ 45

Coursework

¹Instead of the examinations to be taken in elective modules pursuant to § 43 (2) sentence 2, successful completion of coursework may be required. ²In this case the number of credits to be earned through examinations in elective courses pursuant to § 43 (2), sentence 2 will be reduced accordingly.

§ 45a

Multiple-Choice-Procedure

The accomplishment of Multiple-Choice Procedures is governed by § 12a of the APSO.

§ 46

Master's Thesis

- (1) ¹As part of the Master's examination, each student must write a Master's thesis pursuant to § 18 of the APSO. ²The Master's thesis may be assigned and supervised by thesis supervisors of the Department of Informatics of the Technische Universität München ("Themensteller oder Themenstellerin"). ³The thesis supervisors pursuant to sentence 2 are appointed by the Examination Board.
- (2) Work on the Master's thesis should commence after successful completion of all module examinations.

- (3) ¹The period of time between topic assignment and submission of the completed Master's thesis must not exceed six months. ²The Master's thesis is deemed taken and not passed, if it is not delivered in time and without accepted solid reasons pursuant to § 10 (7) of the APSO. ³The Master's thesis must be written in the English language.
- (4) ¹The completion of the Master's thesis consists of a written composition and a lecture on its content. ²The lecture does not affect the grading. ³For the module Master's thesis 30 Credits will be assigned.
- (5) ¹If the Master's thesis was not graded with at least "sufficient" (4.0), it may be repeated once with a new topic. ²The new Master's thesis must be registered no later than six weeks after the notification of the result (Bescheid).

§ 47

Passing and Assessment of the Master's Examination

- (1) The Master's examination is deemed passed when all examinations required for the Master's examination pursuant to § 43 (1) have been passed and a plus credits account of at least 120 credits has been achieved.
- (2) ¹The grade for a module will be calculated according to § 17 of the APSO. ²The overall grade for the Master's examination will be calculated as the weighted grade average of the modules according to § 43 (2) and the Master's thesis. ³The grade weights of the individual modules correspond to the credits assigned to each module. ⁴The overall grade will be expressed by the attribute according to § 17 of the APSO.

§ 48

Degree Certificate, Diploma, Diploma Supplement

¹If the Master's examination was passed, a degree certificate, a diploma, and a diploma supplement including a transcript of records are to be issued in compliance with § 25 (1) and § 26 APSO. ²The degree certificate will be dated on the day when all examination and coursework requirements have been fulfilled.

§ 49

Entry into Force

- (1) ¹These Examination and Academic Regulations shall enter into force on 1 October 2019. ²They shall apply to all students who commence their academic studies at the Technische Universität München as of the winter semester 2019/20. ³In derogation of sentence 1, the Appendix 2: Aptitude Assessment shall apply to all students who commence their studies at the Technische Universität München as of winter semester 2019/20.
- (2) ¹At the same time, the Examination and Academic Regulations for the Master's program in Biomedical Computing of March 16, 2009, last amended by no. 31 of the Summary Changes concerning the aptitude assessment committee of the Master's program of 25 April 2018, shall cease to be in effect. ²Students who started their academic studies at the Technische Universität München prior to winter semester 2018/19 will complete their studies according to the Examination and Academic Regulations pursuant to sentence 1.

APPENDIX 1: Required Modules

¹The examination board can add further Elective Modules to the Elective Course Catalog temporarily or permanently. ²Modifications will be made available on the websites of the Department of Informatics at the beginning of the semester.

1. Required Modules from Informatics (26 Credits)

ID.	Module name	Type of Instruction	Sem	SWS	ECTS	Type of exam.	Exam Duration	Language
IN2021	Computer Aided Medical Procedures	V	WiSe	4	6	Written exam	90-150	EN
IN2022	Computer Aided Medical Procedures II	V+Ü	SoSe	2+2	5	Written exam	75-125	EN
IN2107	Master's Seminar	S	WiSe/ SoSe	2	5	Scientific elaboration		DE/EN
IN2249	Clinical Internship	P	WiSe	6	10	Project work		EN

2. Required Modules from Medicine (17 Credits)

ID.	Module name	Type of Instruction	Sem	SWS	ECTS	Type of exam.	Exam Duration	Language
IN5901	Medical Instrumentation and Computer Aided Surgery	V	WiSe	4	6	Written exam	120	EN
ME0156	Medical Imaging Techniques, Nuclear Medicine	V	WiSe/ SoSe	2	5	Written exam	90	EN
ME580	Pathophysiology and Medical Information Processing	V	WiSe	4	6	Written exam	120	EN

3. Master's Thesis (30 Credits)

ID.	Module name	Type of Instruction	Sem	SWS	ECTS	Type of exam.	Exam Duration	Language
IN2337	Master's Thesis		4.		30	Scientific Elaboration		EN

4. Elective Modules from Biomedical Computing

¹A total of at least 44 credits must be earned from the following elective modules, where a total of at least 5 credits must be earned from the area "Imaging", at least 5 credits from the area "Mathematical Methods and Scientific Computing", at least 5 credits from the area "Programming and Software Engineering", at least 8 credits from the area "Machine Vision, Computer Vision and Pattern Recognition" and at least 6 credits from the area "Computer Graphics, Augmented Reality and Visualization".²Each module can be contributed only once.

ID.	Module name	Type of Instruction	Sem	SWS	ECTS	Type of exam.	Exam Duration	Language
Elective modules from the area „Imaging“ (at least 5 credits)								
PH2001	Biomedical Physics 1	V	WiSe	2	5	Oral examination	25	DE/EN
PH2002	Biomedical Physics 2	V	SoSe	2	5	Oral examination	25	DE/EN

ME25666	Introduction to Bioengineering	V+Ü	SoSe	2+2	6	Written exam	90	EN
Elective modules from the area „Mathematical Methods and Scientific Computing“ (at least 5 credits)								
IN2001	Algorithms for Scientific Computing	V+Ü	SoSe	4+2	8	Written exam	120-180	EN
IN2124	Basic Mathematical Methods for Imaging and Visualization	V+Ü	WiSe	2+2	5	Written exam	75-125	EN
IN2005	Scientific Computing 1	V+Ü	WiSe	2+2	5	Written exam	75-120	EN
MA3305	Numerical Programming 1	V+Ü	WiSe	4+2	8	Written exam	75-120	EN
Elective modules from the area „Programming and Software Engineering“ (at least 5 credits)								
IN1503	Advanced Programming	V+Ü	WiSe	2+2	5	Written exam	75-120	EN
IN2309	Advanced Topics of Software Engineering	V+Ü	WiSe	4+2	8	Written exam	100-160	DE/EN
IN2003	Efficient Algorithms and Data Structures	V+Ü	WiSe	4+2	8	Written exam	120-180	EN
IN2323	Mining Massive Datasets	V+Ü	SoSe	2+2	5	Written exam	75-125	EN
IN2147	Parallel Programming	V+Ü	SoSe	2+2	5	Written exam	75-120	EN
IN2087	Software Engineering for Business Applications - Master's Course: Web Application Engineering	V+Ü	SoSe	2+2	8	Project work		EN
Elective modules from the area „Machine Vision, Computer Vision and Pattern Recognition“ (at least 8 credits)								
IN2246	Computer Vision I: Variational Methods	V+Ü	Irreg.	4+2	8	Written exam	120 - 180	EN
IN2228	Computer Vision II: Multiple View Geometry	V+Ü	Irreg.	4+2	8	Written exam	120 - 180	EN
IN2346	Introduction to Deep Learning	V+Ü	SoSe	2+2	6	Written exam	90 - 150	EN
IN2061	Introduction to digital signal processing	V+Ü	SoSe	3+3	7	Written exam	105 - 175	DE/EN
IN2293	Medical Augmented Reality	V+Ü	WiSe	2+2	5	Written exam	75-120	EN
IN2210	Tracking and Detection in Computer Vision	V+Ü	WiSe	2+4	7	Written exam	75-120	EN

Elective modules from the area „Computer Graphics, Augmented Reality and Visualization“ (at least 6 credits)								
IN2298	Advanced Deep Learning for Physics	V	SoSe	4	6	Written exam	90 - 150	EN
IN2015	Image Synthesis	V	WiSe	4	5	Written exam	75 - 125	EN
IN2018	Augmented Reality	V+Ü	SoSe	3+2	6	Written exam	90 - 150	EN
IN2124	Basic Mathematical Methods for Imaging and Visualization	V+Ü	WiSe	2+2	5	Written exam	75 - 125	EN
IN2222	Cognitive Systems	V+Ü	SoSe	3+1	5	Written exam	75 - 125	EN
IN2067	Robotics	V+Ü	WiSe	3+2	6	Written exam	90 - 150	EN
IN2026	Visual Data Analytics	V+Ü	WiSe	3+1	5	Written exam	60 - 90	EN
IN2210	Tracking and Detection in Computer Vision	V+Ü	WiSe	2+4	7	Written exam	75-120	EN
IN2293	Medical Augmented Reality	V+Ü	WiSe	2+2	5	Written exam	75-120	EN

5. Elective Modules from Support Electives

A total of 3 Credits must be earned from the following electives modules.

ID.	Module name	Type of Instruction	Sem	SWS	ECTS	Type of exam.	Exam Duration	Language
IN9044	Data Privacy	S	Irreg	2	4	Scientific elaboration		DE
WI000159	Business Plan - Basic Course (Business Idea and Market)	S	WiSe/ SoSe	2	3	Project work		EN
IN9006	Entrepreneurship for Small Software-oriented Enterprises	S	SoSe	1	2	Presentation		EN
IN9003	Informatics and Law	V	SoSe	2	3	Written exam	60 - 90	DE
IN9036	Master Your Thesis!	S	WiSe	2	4	Scientific elaboration		EN

The Elective Module Catalogue of the Support Electives will be complemented by modules offered at TUM Language Center and the Carl von Linde-Academy which are published by the Examination Board on the Department's websites.

Explanations:

Sem. = Semester; SWS = Semesterwochenstunden (weekly hours per semester); V = Vorlesung (lecture); Ü = Übung (exercise); S = Seminar; P = Praktikum (practical)

course);

WS = winter semester; SS = summer semester;

For written exams, the "Examination duration" is mentioned in minutes.

APPENDIX 2: Aptitude Assessment

Aptitude Assessment for the Master's Program in Biomedical Computing at the Technische Universität München

1. Purpose of the Assessment

¹Eligibility for the Master's program in Biomedical Computing, in addition to the requirements pursuant to § 36 (1) no(s) 1, 3 and 4, requires proof of aptitude pursuant to § 36 (1) no. 2 in accordance with the following provisions. ²The special qualifications and skills of the candidates should correspond to the Biomedical Computing profession. ³Individual aptitude parameters are:

- 1.1 Ability to do research work and/or basic research and methodological work;
- 1.2 Specialized knowledge from undergraduate studies in respective subjects in accordance with the Bachelor's programs at the Technische Universität München,
- 1.3 Ability to solve complex and difficult problems;
- 1.4 Ability to abstract and transfer the Informatics methods in solving problems in areas of application.

2. Aptitude Assessment Process

2.1 The aptitude test will be held once a year by the Department of Informatics of the Technische Universität München.

2.2 Applications for admission to the aptitude test together with the documents pursuant to 2.3.1 to 2.3.7 and § 36 (1) no. 4 must be filed online by 31 May for the winter semester to the Technische Universität München (absolute deadline). ²Degree certificate and diploma as proof of Bachelor's degree obtained must be filed not later than five weeks after the beginning of lectures. ³Otherwise, pursuant to § 36 (1) no. 1, the enrollment to the Master's program is not yet possible.

2.3 The application must include:

- 2.3.1 a transcript of records containing modules of at least 120 credits, or resp. of two-thirds of the examinations necessary for the undergraduate degree in case of degrees not being subject to the "European Credit Transfer and Accumulation System" (ECTS); the transcript of records must be issued by the responsible examining authority or the responsible office of academic affairs;
- 2.3.2 a curriculum vitae formatted as a table;
- 2.3.3 a written statement of no more than 2 DIN A4 pages in English of the reasons for choosing the Biomedical Computing Master's program at the Technische Universität München in which the candidate explains those specific abilities that make him/her particularly qualified for the Biomedical Computing Master's program at the Technische Universität München; a candidate's exceptional commitment can e.g. be demonstrated by details on program-related vocational training, internships, stays abroad, or program-related further education beyond the attendance and course requirements of the Bachelor's program, if necessary by appropriate documentation;
- 2.3.4 a written essay in English of approx. 1000 words in length; the chairperson of the committee may provide one topic or a selection of several topics for this essay; the candidates must be informed of the topic(s) not later than 1 January;

- 2.3.5 a declaration that both the statement of the reasons for choosing the program and the essay are the candidate's own work, and that the candidate has clearly identified any ideas taken from outside sources;
- 2.3.6 the underlying curriculum (e.g. module catalogue) of the undergraduate degree program;
- 2.3.7 a list of the applicant's best graded modules in the amount of 120 Credits (resp. two-thirds of the examinations necessary for the undergraduate degree) pursuant to 5.1.1 no. 2 incl. a sworn statement of the correctness of the information provided.

3. Aptitude Assessment Committee

- 3.1 ¹The aptitude test is administered by a committee that, as a rule, consists of the Dean of Studies in charge of the Biomedical Computing Master's program, at least one member of the professorial faculty of Informatics, at least one member of the professorial faculty of Medicine and at least one member of the academic staff (wissenschaftlicher Mitarbeiter). ²At least half of the committee members must be professorial faculty. ³A representative of the student body will be a part of the committee, in an advisory capacity.
- 3.2 ¹The members of the committee are appointed by the department council (Fakultätsrat) in consultation with the Dean of Studies. ²At least one member of the professorial faculty is appointed as deputy member of the committee. ³As a rule, the committee is chaired by the Dean of Studies. ⁴Procedural regulations will be in accordance with Art. 41 of the BayHSchG as last amended.
- 3.3 ¹When the Aptitude Assessment Committee takes up the assessment according to these Examination and Academic regulations, the revocable delegation of specific tasks to individual committee members is permitted. ²When according to sentence 1 only one committee member exercises specific tasks, this member has to be a member of the professorial faculty. ³When according to sentence 1 two or more committee members exercise specific tasks, at least half of the members have to be members of the professorial faculty. ⁴The Aptitude Assessment Committee ensures the appropriate distribution of tasks. ⁵In case of an assessment scope for a criterion of the aptitude assessment, and in case that at least two members of the Aptitude Assessment Committee take up the assessment of this criterion, those members assess independently according to the indicated weighting, unless otherwise specified; the points total will be calculated as the arithmetic means of the individual assessments, rounded up to the nearest full point.

4. Admission to the Aptitude Assessment

- 4.1 Admission to the aptitude assessment requires that all documentation specified in no. 2.3 has been submitted in a timely and complete fashion.
- 4.2 Applicants who have fulfilled the requirements will be tested according to no. 5.
- 4.3 ¹Applicants who are not admitted will receive a notification specifying the reasons and providing information on legal remedies. ²Signatory power may be delegated.

5. The Aptitude Assessment Process

5.1 First stage of the Aptitude Assessment Process

- 5.1.1 ¹The committee will assess, on the basis of the written application documents required under no. 2.3, whether or not an applicant is suitable for a program pursuant to no. 1 (First stage of the aptitude assessment process). ²For this purpose, the committee evaluates and grades the candidate's documentation on a scale ranging from 0 to 100 points, 0 being the worst and 100 the best possible result:

1. Academic qualification

¹The curricular analysis is not conducted in the form of a schematic comparison of the modules, but rather on the basis of competencies. ²It will encompass the fundamental subject groups of the Bachelor's programs in Informatics, Mathematics, Physics, Electrical Engineering or Mechanical Engineering at the Technische Universität München listed in the tables below.

Subject Group Informatics	Credits TUM
Informatics Fundamentals (Introduction to Informatics and Programming, Computer Architecture, Software Engineering, Algorithms and Data Structures, Data bases, Operating Systems and Hardware-/Software-orientated Programming, Computer Networks and Distributed Systems, Theory of Computation)	71
Mathematics Fundamentals (Discrete Structures, Linear Algebra, Analysis, Numerical Programming)	30

or

Subject Group Mathematics	Credits TUM
Analysis, Linear Algebra, Discrete Mathematics, Numerics, Probability Theory, Mathematical Modeling, Pure Mathematics, Applied Mathematics	91

or

Subject Group Physics	Credits TUM
Physics Fundamentals (Experimental Physics, Theoretical Physics, Lab Course)	74
Mathematics and other Fundamentals (Mathematics for Physicists, Chemistry, Scientific Computing)	42

or

Subject Group Electrical and Computer Engineering	Credits TUM
Electrical Engineering Fundamentals (Circuit Theory, Practical Course on C Programming, Digital Design, Electricity and Magnetism, Measurement systems and Sensor Technology, Signals, Materials Science for Electrical	78

Engineering, Theory of Electromagnetic Fields, Systems, Electronical Devices, Computer Technics, Electrical Power Engineering)	
Mathematics and other Fundamentals (Mathematics, Algorithms and Data structures, Physics for Electrical Engineering)	42

or

Subject Group Mechanical Engineering	Credits TUM
Mechanical Engineering Fundamentals (Technical Mechanics, Engineering Materials, Machine Elements, Automatic Control, Fluid Mechanics)	55
Mathematics and other Fundamentals (Mathematics for Engineers, Physics, Chemistry, Technical Electricity Science, Information Technology)	40

³If there are no essential differences with regard to the acquired competencies (learning outcomes), the candidate will be awarded a maximum of 55 points. ⁴Missing competencies will be deducted in accordance with the credits of the corresponding modules of the respective Bachelor's program at the Technische Universität München.

⁵There will be no negative points.

⁶Where a GRE or Gate test has to be submitted pursuant to § 36 (1) no. 3, it is assumed that, in case of successful demonstration, there are no substantial differences regarding the level of competencies demonstrated by the undergraduate degree compared to the reference criteria set out in 5.1.1 no. 1 sentence 2 and that the curricular analysis will be conducted according to the abovementioned criteria.

2. Final grade

¹For each tenth of a grade that the average grade determined for the examinations amounting to 120 credits (resp. two-thirds of the examinations necessary for the undergraduate degree) is better than 3.0, the applicant will be awarded one point.

²The maximum number of points is 20. ³There will be no negative points. ⁴Where a degree was obtained outside of Germany, the grade will be converted according to what is referred to as „Bavarian formula“ (bayerische Formel).

⁵If the applicant, at the time he or she files the application, submits a final degree certificate showing more than 120 credits, the assessment will be made on the basis of the modules that were awarded the best grades, up to 120 credits (resp. two-thirds of the examinations necessary for the undergraduate degree).

⁶The grade average is calculated from the graded module examinations up to 120 credits (resp. two-thirds of the examinations necessary for the undergraduate degree). ⁷The overall grade average will be calculated as the weighted grade average of the modules. ⁸The grade weights of the individual modules correspond to the credits assigned to each module. ⁹For the calculation of grade, one decimal place will be taken into account, all further decimal places will be dropped without rounding.

3. Statement of reasons

¹The applicant's written statement of purpose will be evaluated by two committee members and graded on a scale of 0 – 10 points. ²The statement of reasons will be assessed using the following criteria:

1. Exceptional commitment:

Demonstration of relevant qualifications which exceed the knowledge and qualifications obtained at undergraduate degree level, e.g. program-related vocational training, internships, stays abroad (cf. no. 2.3.3)

2. Specific Qualification:

Well-structured presentation of the connection between the specific personal qualification and the contents of the degree program.

³The committee members assess each of both criteria independently. The criteria will be weighted equally. ⁴The points total will be calculated as the arithmetic means of the individual assessments, rounded up to the nearest full point.

4. Essay

¹The applicant's written essay will be evaluated by two committee members and graded on a scale of 0 – 15 points. ²The essay will be assessed using the following criteria:

1. formal and coherent structure,
2. complete and correct in content, coherent argumentation,
3. academic foundation,
4. subject specific English language proficiency.

³The committee members assess each of the four criteria independently whereas the three criteria will be weighted equally. ⁴The points total will be calculated as the arithmetic means of the individual assessments, rounded up to the nearest full point.

5.1.2 ¹The applicant's points total will be calculated as sum of the individual points awarded. ²Decimal places must be rounded up.

5.1.3 ¹Applicants who have at least 70 points will receive confirmation that they have passed the aptitude assessment test. ²In those cases where it was determined pursuant to § 36 (3) that only some subject-specific requirements from undergraduate studies are missing for the Master's program, the committee may make admission subject to successful completion of Fundamentals Exams from the Bachelor's program in Informatics, Mathematics, Physics, Electrical and Computer Engineering and Mechanical Engineering (so-called Brückenkurse) in the amount of a maximum of 30 credits. ³These Fundamentals Exams must be taken in the first year of study. ⁴Failed Fundamentals Exams may be repeated only once and at the next examination date. ⁵The Examination Board may make the admission to individual module examinations dependent on the successful completion of the Fundamentals Exams.

5.1.4 ¹Unsuitable applicants with a total of fewer than 50 points will receive a rejection notice, signed by the TUM Board of Management and specifying the reasons for

rejection and providing information on legal remedies. ²Signatory power may be delegated.

5.2 Second stage of the Aptitude Assessment Process

5.2.1 ¹The remaining applicants will be invited for an Aptitude Assessment Interview. ²In the second stage of the aptitude assessment process, the applicant's qualification at undergraduate level and the result of the assessment interview will be evaluated. ³If the amount of points stated in 5.1.3 sentence 1 was not achieved, the same also applies for applicants who have to successfully complete Fundamental Exams according to 5.1.3 sentence 2. ⁴Interview appointments will be announced at least one week in advance. ⁵Possible time slots for interviews must be announced before expiration of the application deadline. ⁶The interview appointment must be kept by the applicant. ⁷If the applicant is unable to attend an aptitude assessment interview due to reasons beyond his/her control, a later appointment may be scheduled upon an applicant's well-grounded request, but not later than two weeks before the beginning of classes.

5.2.2 ¹The Aptitude Assessment Interview is to be held individually for each applicant. ²The interview lasts at least 20 but not more than 30 minutes for each applicant and is held in both German and English, but may be completely in English upon request. ³The interview will focus on the following topics:

1. Exceptional commitment that gives reason to expect that the level of capacity obtained at the undergraduate degree level in general or at least concerning the area of specialization is exceeded noticeably (0 to 15 points):
 - Is there any specific qualification for a concrete specialization in the field of the degree program, proved by additional modules or non-university activities (e.g. membership or activities in relevant organizations) in that area?
 - Is there evidence of outstanding determination in the curriculum vitae (e.g. additional subject-related internships, relation between previous occupations and the degree program)?
 - Is there specific experience in research (e.g. specific research orientation in the previous academic studies, participation in research projects)?
2. Aptitude parameters according to no. 1.1 and 1.2 (0 to 15 points):
 - Presentation of subject-related expertise, previous main study focus
 - Qualifications acquired in the undergraduate degree program in the subject groups mentioned in 5.1.1.1
 - Subject of the thesis
3. Communication skills (0 to 15 points):
 - Ability to illustrate and discuss facts in a clear, fluent and adequate way,
 - One's own thoughts and opinions are expressed precisely and comprehensive answers are structured logically during the interview,
 - Questions relating to the first degree and / or the main study focus are answered terminologically correct and comprehensible at the same time,
 - Statements are convincingly based on arguments and supported by reasonable examples,
 - Questions regarding scientific topics as well as one's own competencies and expectations are understood without problem or if necessary clarified through further inquiry

⁴The above topics may cover the documentation submitted pursuant to 2.3. ⁵Any subject-specific academic knowledge that is to be taught in the Master's program in

Biomedical Computing will not affect the decision. ⁶With the applicant's approval, a representative of the student body may sit in on the interview.

- 5.2.3 ¹The Aptitude Assessment Interview will be conducted by at least two members of the committee. ²The committee members will grade each of the three topics set out in no. 5.2.2 independently, each with the same weighting. ³Each member will grade the result of the interview on a scale from 0 to 45, 0 being the worst and 45 being the best possible result. ⁴The points total will be calculated as the arithmetic means of the individual points. ⁵The result will be rounded up to the nearest full point.
- 5.2.4 ¹The applicant's points total in the second stage will be calculated as the sum of all points obtained under 5.2.3 and the points under 5.1.1.1 (academic qualification) and 5.1.1.2 (grade). ²Applicants with 70 or more points will be deemed suitable.
- 5.2.5 ¹The applicant will be notified of the result of the aptitude test in writing - where applicable, subject to the requirements determined in stage 1, 5.1.3 sentence 2. ²The notice must be signed by the TUM Board of Management. ³Signatory power may be delegated. ⁴A rejection notice must specify the reasons for the rejection and provide information on legal remedies.
- 5.2.6 Admissions to the Master's program in Biomedical Computing shall apply to all subsequent applications for this program.

6. Record

¹The Aptitude Assessment Process must be documented, including the date, duration and location of the assessment, the names of the committee members, the applicant's name, and the decision of the members of the committee as well as the complete results. ²This record must contain the essential reasons for the decision and the topics discussed in the interview held with the applicants; these reasons and topics may be recorded in note form.

7. Repetition

Applicants who have failed the aptitude test for the Master's program in Biomedical Computing may register for one repetition of the Aptitude Assessment Test.

Issued due to the resolution of the Academic Senate of the Technische Universität München of 18 July 2018 and the approval of the President of the Technische Universität München of 25 October 2018.

Munich, 25 October 2018

Technical University of Munich

Wolfgang A. Herrmann
President

These Examination and Academic Regulations were recorded 25 October 2018 at the university; the recording was announced on 25 October 2018 by notice in the university. Therefore, the official date of announcement is 25 October 2018.