Guide for the MSc in Biomedical Engineering

(Kandidatuddannelsen i Medicin & Teknologi)

Study year: 2023/2024

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Version 2.2 (31 August 2023)

This guide is subject to frequent updates - make sure you have the newest version available at:

home.healthtech.dtu.dk/jw/medtek/guide/

1 Target audience

This guide concerns the joint MSc program in Biomedical Engineering offered by the Technical University of Denmark (DTU) and University of Copenhagen (KU).

This report is relevant for all students in the MSc program. However, since many decisions must be taken in the BSc program, it is relevant for students during their third term in the BSc program and onwards.

2 Nomenclature

E = Fall term F = Spring term
~ = means course that corresponds to

GR = General Competence Courses (= mandatory courses). 30 ECTS.

TS = Technological specialization courses. A minimum of 30 ECTS must be acquired.

VF = Elective course. Up to 30 ECTS.

Thesis = Master thesis. Between 30 and 35 ECTS.

Some text is translated into Danish and shown in parenthesis and in italic.

The Programme specification has changed for the uptake of September 2022. As a consequence, some of the text in this guide has changed, so that new text appear in another font.

3 The overall set of rules

It must be emphasized that the rules and regulations at all times are governed by DTU. Thus, a lot of aspects are fixed; these can be studied in the Study handbook (*Studiehåndbogen*) which can be accessed via this link

studieinformation.dtu.dk/english/master-of-science-in-engineering/biomedical-engineering

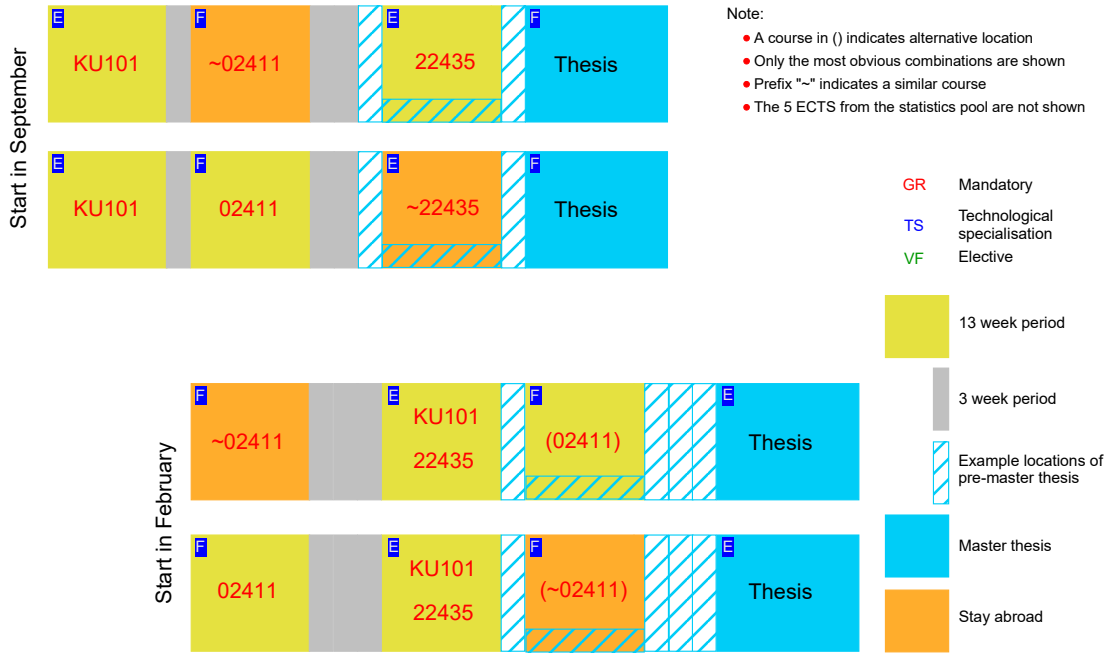

Figure 1 Overview of the structure of the program. See course details at www.kurser.dtu.dk.

It is the responsibility of the student to know the rules. The HoS cannot overrule them; the only way the rules can be circumvented is by applying for, and obtaining, dispensation. To get a dispensation, you will, of course, need a very good reason.

Thus, only a minimum of referrals will be to DTU rules, as these can change asynchronously with this guide. In the event of inconsistencies, DTU rules prevail.

Finally, please be aware of some practical aspects with respect to KU:

BSc: https://kunet.ku.dk/studie/medicin-teknologi-ba/Sider/default.aspx

MSc: https://kunet.ku.dk/study/medicine-technology-ma/Pages/default.aspx

4 Introduction and overall structure

This guide helps you design your MSc program in such a way that you can

- start in September or February *and*
- take one term at a foreign university *and*
- conduct the master thesis during the last term *and*
- complete your studies within two years.

The overall structure is shown in Figure 1. There are three terms with courses and one with the master thesis. For both starting points, two possibilities for incorporating a term at a foreign university are shown. Only 25 ECTS of the GR courses are shown. A few examples of pre-master thesis courses (*specialkursus*) are presented, but there are many other possibilities. Below is listed a number of constraints which formed the basis of the structure of Figure 1:

- For students starting in September, there are two fall terms and one spring term. For students starting in February, there is *only one fall term*, but two spring terms. Thus, be aware of the following:

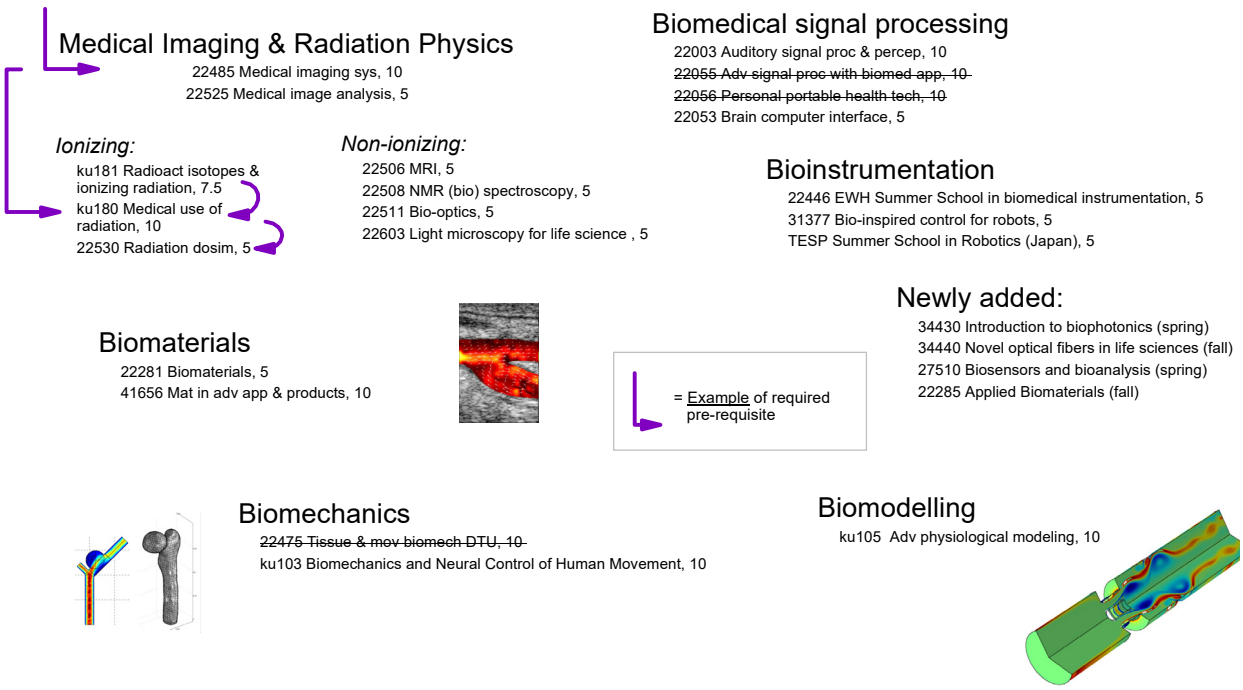

Figure 2 Overview of all TS courses attempted grouped into focus areas. Areas naturally have some overlap. Some titles are abbreviated. Arrows indicate *an example* of prerequisites from other programs as well as prerequisites within the program. Actual pre-requisites must be verified by the student.

- For start in February, it is, in general, not recommended to go abroad in the only fall term available.
- There are more GR and TS courses scheduled for the fall than for the spring. For students starting in February, this schedule conflict can be partly remedied by establishing a special course (*specialkursus*).

- KU101 Pathophysiology is a course that follows a somewhat different learning paradigm and provides the basis for a number of the TS courses; thus it should be taken as early in the study plan as possible.

A stay at a foreign university can also take place during the thesis work (not shown in Figure 1); this makes the puzzle much easier. However, remember that a Master thesis cannot be transferred; it must be defended at DTU or at KU.

5 Content of program - TS courses

The TS courses cover a large number of focus areas as seen in Figure 2.

Some courses can be moved from one fall term to another, other courses are in *course chains* and must be taken in the correct order. Also, note that at least one course follows an alternative term schedule (KU181).

The areas in Figure 2 are closely related and most courses can logically be grouped among several areas. Notice that you have to obtain at least 30 ECTS within the pool of TS courses; subject-wise you can select completely as you wish.

It is quite important to investigate thoroughly which pre-requisites the courses have so that you can adhere to the course chains when relevant. For students starting in February, this is a bigger challenge than for students starting in September.

For DTU students there is a special course plan called "*overgangsordning*". For students that happen to be on this plan during the fall term and who subsequently start the MSc program in February, it is very important to select the courses during the "*overgangsordning*" with due diligence.

6 Master thesis and pre-thesis project

It can be a good idea to include a pre-thesis project in the form of a special course (*specialkursus*) in your study plan. The pre-thesis project will be in the form of a special course. Please consider these aspects:

- A master thesis is normally 5 months. This is very short time to get acquainted with a topic, be productive (*i.e.,* make the actual thesis work) and finally write a report. The work of being acquainted could conveniently be placed in a pre-project.
- If the pre-thesis is within biomedical engineering (which is normally the case), the points earned here can be applied according to point 2 in Section 8.
- Typically, you would make the pre-project in the term just before the master thesis.
- The pre-project is intended to be within the same topic and with the same advisor as the master thesis.

Please remember that a pre-thesis project is not something you are guarantied. It is a matter of supply and demand between students and advisors and it is your responsibility to find an advisor.

6.1 How to find an advisor

If you have an idea to a project (maybe in collaboration with a third part such as a company, hospital, etc), then there are different approaches you can follow to find a potential advisor at either DTU or KU:

- Consider the teachers that you have had in previous courses.
- Consider searching for the topic at DTU's internal research database (orbit.dtu.dk) or the keywords each researcher is associated with.
- Consider searching for the topic at Web of Science (bibliotek.dtu.dk/dtu_studerende) to see, if there are any DTU or KU researchers working in the field.

Please be informed, that it is the not the job of the (vice)head of studies to help with this, unless the situation has reached a deadlock.

6.2 Project at a company or hospital department

If you plan to conduct your thesis at a company or hospital department, there are a number of things that you should consider to have explicitly discussed with the company and the KU or DTU main advisor before the project is agreed upon:

- Typically such a project involves experiments, which means that
  - •access to the laboratory should be ensured
  - •the instruments and materials need should be available

•the staff with knowledge about the experiments should be available

- Since the project typically will be conducted mainly at the external partner, it would be a very good idea to make a midterm project report, to ensure that lack of proper progress is detected in due time.

You should be especially careful, if you do not know the advisors beforehand.

6.3 Rules

The general rules governing the Master's thesis differ slightly between DTU and KU. For students of this program, however, the DTU rules prevail in the majority of cases. Please note, that the following must be determined before the start of the thesis:

- Start date, date of handing in the report and normally also the date for the defense. The defense should be placed no later than 14 days after hand-in.
- Number of ECTS points. This must match the duration (as specified in the DTU study handbook).

See also "Projects at KU" on page 7.

6.4 Management aspects

First of all, remember in your master thesis, you are the project leader. Second, if meetings occur rare and often takes place virtually, remember to precisely define or describe the way of collaboration at the very beginning of the project, especially for projects involving three or more partners.

7 About taking one term at a foreign university

Please be aware of the following aspects:

- It is expected that the university chosen by the student is the one that provides the best choice of courses within the specialization area(s) of the student. Most courses will be TS courses.
- Normally, all courses within biomedical engineering will be accepted as TS courses, *i.e.,* courses that contain *both* technical and medical subjects. Details: they have to be at graduate level. Examples of courses accepted as TS courses: Bioinstrumentation, Physics of medical imaging. Not accepted: Signal processing, Cell biology, Systems Neuroscience.
- When going abroad, you should be aware that you cannot be certain to obtain a seat in the courses you plan to take when you finally arrive. Thus, it can involve some risk to postpone a mandatory course such as 22435 Medical product development to the foreign university. Specifically, if a substitute to 22435 cannot be taken, the entire MSc program will end up having to be extended by one term. You should also be aware of another timing aspect: "*Forhåndsmerit*" must be obtained *before* the last opportunity to take 22435 is passed.
- For students who plan a stay abroad in the spring: Many universities outside Denmark begin their spring semester early in January. This can make it difficult to participate in a 3-week course in January. Consequently, you have to take 30 ECTS in the 13-week period in the preceding fall.
- If the stay abroad is just prior to the master thesis, be sure to have the latter planned before leaving to study abroad.
- Check the DTU rules for the potential case, where you fail the exam of a course at a foreign university.

- It takes a long time to plan a stay at a foreign university (typically one year). So start planning in good time. Replies to mails sent to HoS could take up to 10 working days (though respond time is usually shorter).
- If the foreign university requires a certificate of your ability to speak/write/understand English, this is not a matter for DTU/KU.
- The HoS offers only a limited service with respect to documents that you need for studying abroad

8 TS Courses, procedures

For clarity, the above means, that apart from taking courses from the TS pool, the only ways to obtain TS credits are:

1. From courses at foreign universities (*Procedure*: Handled via "Forhåndsmerit").
2. From special courses at KU and DTU. Maximum 10 ECTS. (*Procedure*: if in doubt whether the topic is acceptable, ask the HoS at DTU beforehand. When an email (or other written documentation) with *title of course*, *full name*, *study ID* as well as *the grade* has been received, forward this to the HoS with specific request for obtaining TS points.)

In both cases, courses must be clearly within biomedical engineering (*i.e.,* have both technical and medical/biological content).

9 Transfer of courses from BSc to MSc

Pre September 2022: In the rare case, where a student at the BSc program obtains credit for one of the mandatory courses at the MSc program (KU101 Pathophysiology, 22435 Biomedical Product development, 02411 Statistical Design and Analysis of Experiments or one of the courses in the statistical pool), the requirement of the GR pool can be reduced with the corresponding amount of ECTS points and the requirement of the TS pool will be *increased* by the same amount. The student has to inquire about this (via an email to the MSc HoS).

Post September 2022: In the rare case, where a student at the BSc program obtains credit for one of the mandatory courses at the MSc program (KU101 Pathophysiology, 22435 Biomedical Product development, 02411 Statistical Design and Analysis of Experiments), the requirement of the GR pool can be reduced with the corresponding amount of ECTS points and the requirement of the TS pool will be *increased* by the same amount. The student has to inquire about this (via an email to the MSc HoS).

TS courses taken while studying towards the BSc program will not be transferable.

10 Internship (*Praktik*)

Just as you can always arrange a special course if you can find an advisor at DTU or KU, it is also possible to make an internship in a company. However, it must meet all the requirements of a special course including a report that is graded. The report must reflect an amount of scientific work that matches the number of ECTS points.

You can also do an internship at KU (maximum 5 ECTS) in your own or someone else's startup. You will take part in all phases from idea development to realization, and participate in workshops on innovation and entrepreneurship at SUND Hub. Learn more and register at:

English: `sundhub.ku.dk/sund-hub-uk/programs/academic-internship`
Danish: `sundhub.ku.dk/programmer/projektorienteret-forloeb`

or contact anna.v.jacobsen@sund.ku.dk or Tine Alkjær Eriksen (vHoS).

11 Different schedules at KU and DTU

Please consider that the schedules (including exam periods) differ by a variable amount from year to year between KU and DTU. *Studieudvalget for Medicin og Teknologi* (the Study board for Biomedical Engineering) and the Heads of studies try to remedy this on an annual basis. As an example, the exam in KU101 Pathophysiology is planned to take place at one of the very first workdays in January. This will make it possible to take 22053 Principles of Brain Computer Interface.

Sign-up for courses is also different. You have to sign-up for both DTU and KU courses via cn.inside.dtu.dk. However, when you visit the page on DTU portalen, **Registration deadlines for courses and examinations**, please be aware that the *Supplementary registration period* (*Eftertilmeldingsperiode*) does not apply for KU courses; so for these, you need to make final decisions in advance.

12 Resources

If you have a question and cannot find the answer on the DTU and KU webpages nor at the intranet, KUnet, then please use this directory to direct the question to the right entity:

Studievejledningen (studievejl@adm.dtu.dk) handles:

- Admission (*optagelsesvejledning*)
- Advice on conduct of study program (*Gennemførelsesvejledning*)
- Implementation (*studieplanlægning – på det processuelle niveau*)
- Advice on rules and regulations (*Regel-vejledning*)
- Advice on dispensation from the rules (*Dispensationsvejledning*)

The HoS at DTU and HoS at KU handle:

- Matters of structure
- Academic content

Both can be found at the homepage of the education.

In addition, there is a welcome meeting for all new master students in the first week of the term in September and normally also in February.

Typically a Biomedical Engineering Information Meeting (*Møde om kandidatuddannelsen*) will be held in the fall and all bachelor students are strongly encouraged to participate. See link at:

https://home.healthtech.dtu.dk/jw/medtek/infomeeting/2022/info_moede_opslag.pdf

12.1 Projects at KU

If you plan to do a project at KU, you must use these forms:

Bachelor thesis:

https://kunet.ku.dk/studie/medicin-teknologi-ba/Sider/emne.aspx?topicid=6ececb9b-9a89-4de0-b1c7-0b8325e7c401

Master thesis:

https://kunet.ku.dk/study/medicine-technology-ma/Pages/topic.aspx?topicid=6ececb9b-9a89-4de0-b1c7-0b8325e7c401

13 Questions to consider

Since the rules change quite often, here are a number of questions that may be relevant:

- Are you able to start earlier than primo September? (if yes, you might be able to include some of the new 3-week periods in July and August)
- When is the last day of re-selection of courses (*e.g.,* if you have signed up for a course in August, what is the latest time that you can change your mind before it is binding?)

14 Admission to the MSc program

The homepage of the program at www.dtu.dk lists the pre-requisites for entering the program.

The general rules have changed quite a bit over the last 5 - 10 years, so be *sure* you know them, save them to disk (for documentation purposes) and follow them!

14.1 Especially for non-Biomedical Engineering students seeking admission

In addition to taking courses to meet entry requirements, the applicant may consider to take possible pre-requisite courses to be able to follow relevant TS course specified in Figure 2.

15 Elective courses

This information pertains partly to what you can do in DTU's system for signing-up for courses.

15.1 DTU

At DTU you can take any graduate course (see www.kurser.dtu.dk).

15.2 KU

At the University of Copenhagen, you can use your elective credits towards the TS courses in your program (*i.g.,* KU105, etc.) without further course approval.

Other courses offered can be found via the course catalog:

kurser.ku.dk

Courses from other programs (including the BSc BME program), must be pre-approved by DTU and you need to apply for enrollment as a guest student at the KU faculty offering the course. Please be aware of the course language, possible oversubscribed courses and admission requirements.

Also, the application deadlines differ from DTU. For example, at the Faculty of Health and Medical Sciences the deadlines are 1 June for courses running in fall semester and 1 December for courses running in the spring semester:

https://healthsciences.ku.dk/education/student-mobility/guest-students/

Other deadlines apply for other faculties, for example Faculty of Science where this link applies:

www.science.ku.dk/english/courses-and-programmes/other-study-opportunities/credit-students

Information about credit transfer (merit) at DTU:

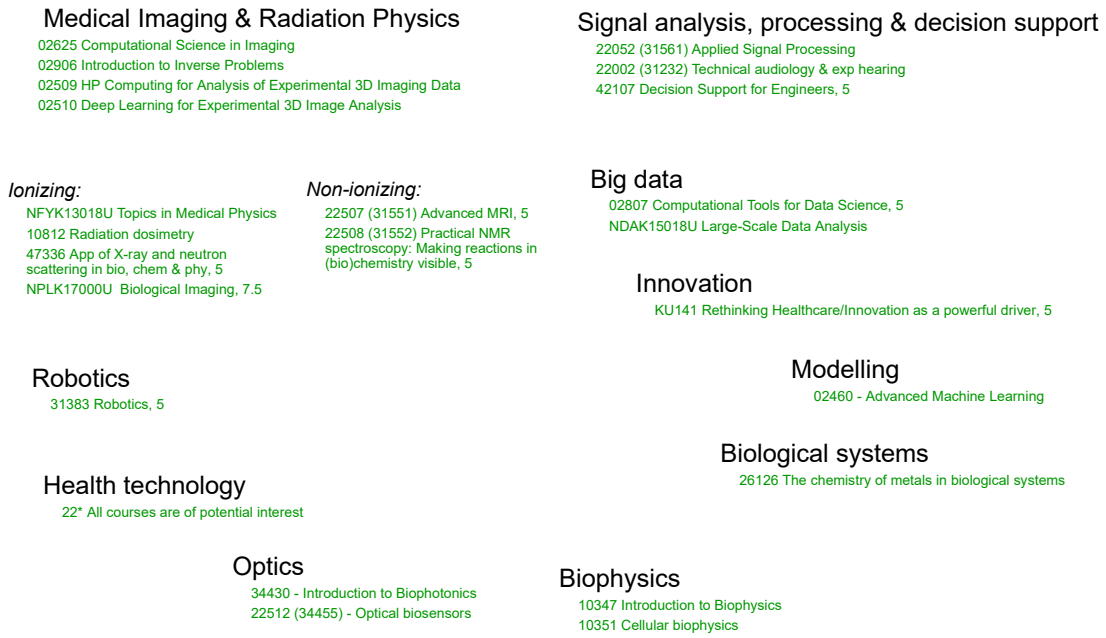

Figure 3 A figure still in embryo: An attempt to make an overview of some relevant elective courses from KU and DTU. Please feel free to supply the HoS with additional courses to this figure.

auth.dtu.dk/dtu/login?service=https%3a%2f%2fmerit.dtu.dk%2f

15.3 Short list of some of the courses

A none-exhaustive list of possible elective courses that might be relevant is given in Figure 3.

16 Grades in courses

If you are evaluated on the 7-level grade system at a course at KU, this grade will automatically be transferred to your diploma which will eventually be presented by DTU upon graduation.

17 Letters of recommendation

The HoS does not write letters of recommendation for students. You can consider asking this of your bachelor thesis advisor.

18 Appendix

18.1 Resources at a glance

The general curriculum:

studinformation.dtu.dk

where you can see the four types of courses / projects you have to take and all the rules related to the education. Also look at the resource page

https://home.healthtech.dtu.dk/jw/medtek

which provides a lot of practical information. Also be sure to know this

kurser.dtu.dk

where you will find all the courses at DTU and the KU courses that are included in the program. This page allows a lot of different search options that helps you construct your curriculum (*e.g.,* you can iden-

tify the courses which correspond to an updated version of Figure 3). You can also search the corresponding database at KU:

kurser.ku.dk

where the courses that are *not* in the BME program require prior approval.

18.2 Changes for uptake 2022 and 2023 at a glance

DTU induce changes to all MSc programs in 2022 and 2023. For the BME MSc program, the changes are illustrated in Figure 4. The mandatory courses in innovation and sustainability are not accompanied by course numbers, since several courses can be used. Please see `studieinformation.dtu.dk` for details. Also please note, that in case of discrepancies between this document and `studieinformation`, the latter shall prevail.

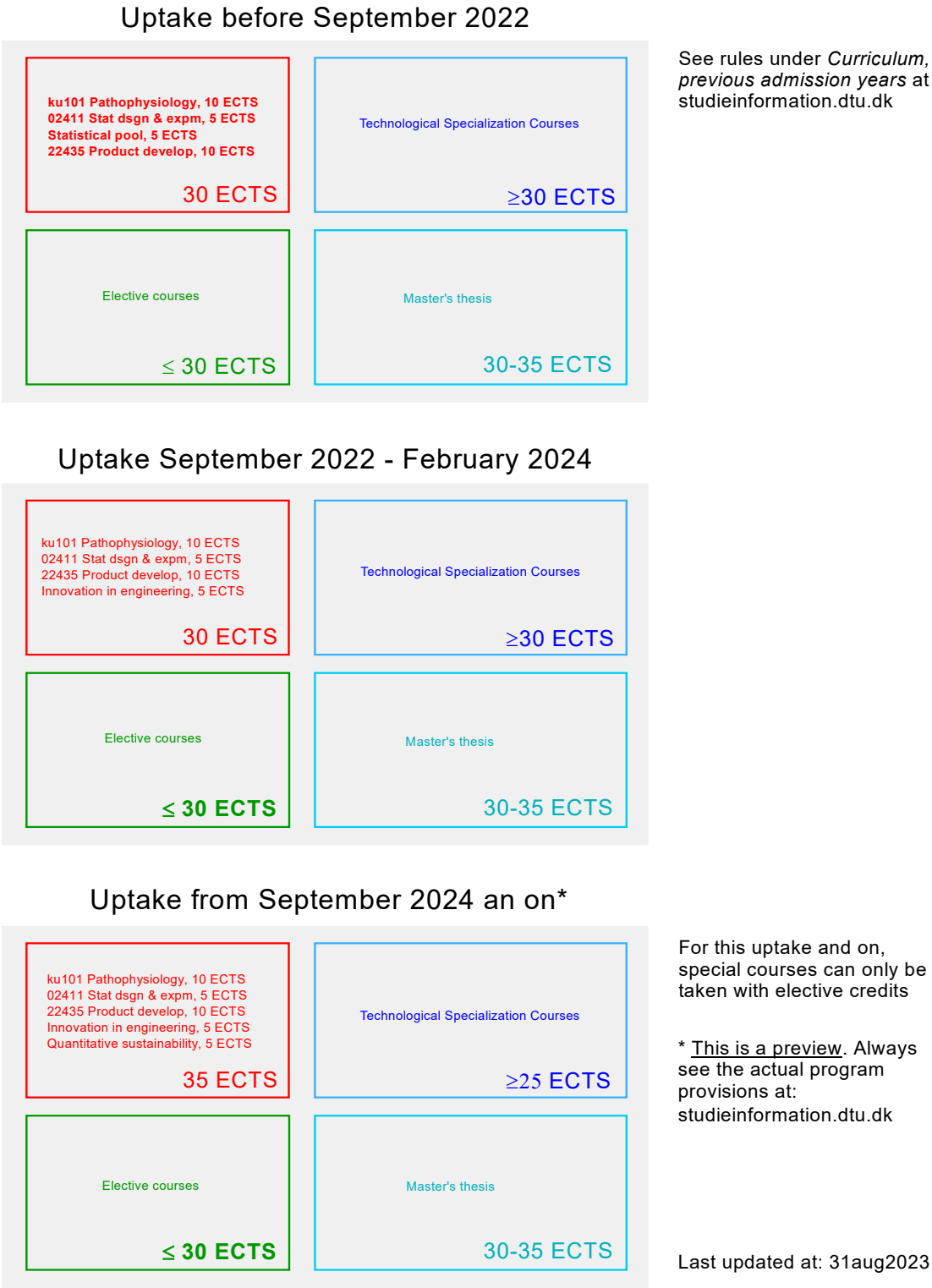

Figure 4 Overview of changes with respect when you were admitted to the program. Entire study is 120 ECTS.

The layout in Figure 4 is shown in the old framework, solely to visualize the changes as efficient as possible. It is the actual time of admission to the MSc program that applies in Figure 4, not the start time of a possible "Overgangsordning". Student on *Uptake February 2022* and before are on the old program. With respect to the "statistical pool", please also see Section 9.

Finally note that due to the introduction of the "track" in Digital Health, some additions to the present program are expected.

Additional details on the changes can be found in `studieinformation.dtu.dk`.

18.3 List of recent BSc or MSc projects for inspiration purposes (list of 2020)

1. Automatic detection and characterization of nocturnal eye movements
2. Automatic detection and characterization of the transition period from wake to sleep
3. Automatic detection and characterization of sleep spindles
4. Immune cell migration in Multiple Sclerosis
5. Optimized NMR Imaging and post-processing Protocols for Assessment of Global Cardiac Function in AMI animal model
6. Biofilms treated with hyperbaric oxygen
7. Biofilm properties
8. Cellular deformation in response to hydrodynamic stress
9. Can the interval between first and second heart sounds be used as an estimate for the QT-interval?
10. Transcriptomic characterization of in vivo-like model of chronic infection
11. In vitro transport of insulin from microcontainers
12. Imaging of chemical microenvironment of pathogenic biofilms
13. Activity monitoring of infants and young children using EMG shorts
14. Training of infants using eye tracking
15. Pattern classification and recognition on motion tracking data of infants
16. Creating a Baby-Kinect
17. Sleep-Awake-Move in patients with Parkinsons disease
18. Development of an anatomical realistic carotid artery phantom
19. Finite element modeling of the biomechanics in the human heart
20. Prototyping a new fluorescence microscope for long-term imaging of living specimens
21. Electric therapy in wound healing
22. Implementation of open-source tomographic reconstruction algorithm for preclinical PET data and comparison to vendor software
23. Super-resolution imaging using ultrasound
24. Role of Signal Processing in Eye Care

25. ArtTribute
26. BCI and Eye tracking for Smart Homes
27. BCI controlled FES system for complete neurorehabilitation of post stroke patients
28. Hybrid Brain Computer Interface Systems for Drone control in 3D
29. EEG and TES neurostimulation
30. Multimodal physiological timeSeries analysis for outcome prediction in the intensive care unit
31. Real-time Automatic Detection of Atrial Fibrillation
32. Real-time communication system for the disabled
33. Advanced topics in computational and experimental biofluid mechanics
34. Magnetic Resonance Imaging and Spectroscopy Technology
35. 3D visualization of mummies
36. Forensic age-at-death estimation using CT scanning of bones
37. Modeling speech intelligibility in cochlear implant recipients
38. Early reflection processing in cochlear implants
39. Model-in-the-loop fitting of hearing-aid amplification
40. Developing a continuous speech test for hearing assessment
41. Microcontainers for improved treatment of biofilm
42. A Real-time hearing-aid simulator for psychoacoustic experiments
43. The Role of Fibroblasts in Atrial Fibrillation
44. InstaPatch – Instantaneous monitoring of allergic reactions
45. Fabrication of biodegradable microcontainers for controlled oral drug delivery
46. Discovering new biomarkers for auto-immune diseases
47. Identification of peptide ligands in drug delivery
48. Immuno-backpacks – can they deliver drugs to brain cancers
49. Microcontainers for improved treatment of biofilm
50. Microcontainers for oral delivery of probiotics
51. Microneedles for transdermal drug delivery
52. Paper based sensor for the quantitative measurement of creatinine in urine
53. Detection of the semi-defined autonomic arousal in sleep and analysis of its clinical application
54. Detection of early biomarkers for Parkinsons disease
55. Detection of early biomarkers for Alzheimers disease
56. Detection and quantification of sleep microstructures in EOG signals

57. Investigating cross-frequency couplings in brain circuits relevant in depression and schizophrenia
58. Improved diagnostics of apoplexy by analyzing brain states
59. Bærbart hjerteplaster til monitorering og analyse af sygdomme fitness eller rehabilitering
60. Automatic detection of epileptic seizures
61. Styring af computer med hjernesignaler
62. Integration of longitudinal Sensor data for Monitoring Activity and Metabolism
63. Integration of longitudinal Continuous Glucose Monitoring data with matched smart-phone Images of dietary intake
64. Automatic detection of seizures based on polymodal recordings of video EEG EMG and ECG.
65. Follow-up functionality and user-friendly presentation of electroretinography results
66. Investigating mucoadhesion of chitosan coated microcontainers for oral drug delivery
67. Resonance in the cardiovascular system
68. Sleep detection using in-ear non-contact sensors
69. Hjernens dynamik under normal funktion og under epilepsi
70. Pulse wave velocity estimation of blood flow in the carotid artery
71. Development of a physical model for studying intracranial pressure
72. Diagnosis of arteriosclerosis
73. Hydrocephalus and intracranial pressure