**Update on PT-ICT electives**

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All PT-graduates have direct access to the master HTI, regardless of the courses in the elective space. PT-ICT students who may be interested to continue their studies in the direction of Data Science, Artificial Intelligence or Computer Science can have direct access if they choose suitable electives. Of course, those electives are highly relevant for the continuation in HTI as well.

This document provides an overview of the relevant courses and elective packages for PT-ICT students. The first four sections focus on relevant master programs, the last few sections on elective packages offered by Data Science and Computer Science. We conclude with a table of the mentioned courses with reference to the mentioned masters and elective packages (Appendix 1).

Some remarks for all students:

* + Check the OER requirements regarding your elective space [here](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/curriculum/overview-elective-courses-and-packages/oer-requirements-elective-space/?L=2).
	+ In addition to the 20 ects obligatory courses of your track, you need to choose 15 ects additional engineering courses. Preferably this is a complete elective package as listed [here](https://educationguide.tue.nl/programs/bachelor-college/elective-courses/a-z-electives/) because of the coherence and level of the courses.
	+ Engineering courses are courses with course codes 2xxxx – 8xxxx and the Jxxxx courses as mentioned in appendix 2.
	+ Overlap is not allowed; check the overlap table [here](https://educationguide.tue.nl/programs/bachelor-college/elective-courses/overlap-courses/). Special attention is required for the overlap of JBI020 (needed for Data Science and entrepreneurship) with 2IL50 (needed for Computer Science, Data Science and AI resp Data Science in Engineering).
	+ As packages in the ICT domain may contain courses that are also an obligatory part of the ICT-track you may need to combine an elective package with another related course. This document describes some options to do so. You may combine up to 15 ects for one elective package and up to 25 ects for two elective packages. You always need to ask permission of the Examination Committee (EC-IS), see [here](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/exam-committee-is/).
	+ If you consider proceeding to a computer science or data science related master after your bachelor, you may choose to combine the courses you need for direct access in your elective space. This is a good motivation to ask the examination committee for approval of your package. Also via this [link](https://educationguide.tue.nl/programs/bachelor-college/majors/psychology-technology/exam-committee-is/).
	+ In case you consider another master than HTI, always check the entrance requirements at the website of that master. Ask the FTC (the departmental admission committee) of the program whether you will be accepted already in an early stage. This is free, there are no obligations to really start and you know how to change your electives in case that is needed.
	+ In case you consider another master than HTI, always check which courses are excepted as deficiency. Most TU/e-masters allow direct admission with up to 3 courses deficiency, and then require that you take those courses as part of the elective space of your master (so-called homologation courses).

**MSc Data Science and Entrepreneurship (DS&E)**

**The two-year master's program Data Science and Entrepreneurship is a joint master by Tilburg University and Eindhoven University of Technology and therefore a truly interdisciplinary business-technology-analytics program.** Links to the master at the [JADS page](https://www.jads.nl/data-science-master-programs-overview.html) and the [TU/e site](https://www.tue.nl/en/education/graduate-school/master-data-science-and-entrepreneurship/).

The Data Science for IE&IS elective package is developed for direct admission, see [here](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/JADS%20Coherent%20package%20voor%20BSc%20TBK%20en%20PT_2019_2020.pdf). For PT-ICT only two courses are needed for admission because the third course – Data modeling & Databases 2ID50 is already in your mandatory ICT-track.

* + JBI020 Foundations of Computing Q2-E (level 2). This course is required for direct admission to the JADS master program.
	+ JBI030 Data Mining Q3-E (level 2). This course is required for direct admission to the JADS master program.

Those two courses can be completed to a valid technical package of 3 courses by the following courses:

* + 2DBI00 Linear Algebra Q4-E (level 1) from [Data Modelling Foundations](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Data%20Modeling%20Foundations%202019.pdf)
	+ 2ID70 Data intensive systems & applications Q3-D (level 3) from [Data Modelling Foundations](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Data%20Modeling%20Foundations%202019.pdf)
* 2DI90 Probability and Statistics Q4- C (level 2)
* JBI100 Visualization Q2-D (level 2)

Note: PT-ICT students need two level-3 courses in their elective space. One in the USE-learning line and one other; 2ID70 could play this role.

**MSc Data Science and Artificial Intelligence (DS&AI)**

The new Master DS&AI is intended for students interested in studying and combining advanced data analysis techniques with AI methods and techniques, in order to understand, use and develop intelligent systems to support and strengthen the human intellect. Link to the [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/special-masters-tracks/data-science-in-engineering/dsie-track-of-computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/master-data-science-and-artificial-intelligence/).

The intended launch will be September 2021. Currently, students enroll for the master Data Science in Engineering. The DSiE master is embedded as a special track within the Computer Science and Engineering (CSE) master (and will be phased out gradually once DS&AI is launched). Check link to FAQ [here](https://assets.tue.nl/fileadmin/content/Education/2_GraduateSchool/Master%20programs/Data%20Science%20and%20Artificial%20Intelligence/FAQ_Postponement_EN.pdf).

Admission to DS&AI in general:

* Logic and Set Theory (2ITS60)
* Linear Algebra (2DBI00)
* Probability and Statistics (2DI90)
* Data Structures (2IL50)
* Data-Modeling and Databases (2ID50)
* (Object-oriented) Programming and applying programming for problem solving (2IP90)
* Visualization (JBI100)
* Data Mining (JBI030) or Machine Learning (2IIG0)

PT-ICT students need for admission

* Linear Algebra (2DBI00) Q4-E level 1
* Probability and Statistics (2DI90) Q4-C (level-2)
* Data Structures (2IL50) Q3-B (level 2)
* Visualization (JBI100), Q2-D level 2
* Data Mining (JBI030), Q3-3 level 2 or Machine Learning (2IIG0), Q2-C level 3

**Two examples how you can organize these courses in your PT-ICT program:**

1. You take all 5 courses and you can apply for direct admission to DSAI, if you want. These 5 courses you can also use as the 15 plus 10 ects coherent packages you need in your electives.
2. You take 3 out of these 5 courses and use them as your technical package of 15 ects. You still can ask admission if you want, because you miss not more than 3 courses for direct admission. The 2 remaining courses will become part of your DSAI program in case you want to do this master: 2 mandatory electives, called homologation courses.

**MSc Data Science in Engineering (DSiE)**

Technological and societal changes have led to an explosion of digitally available data. Exploiting this data to its fullest extent, in order to improve decision making, increase productivity, and deepen our understanding of scientific questions, is one of today's major challenges. Data science is an emerging discipline that aims to address this challenge. It is a multi-disciplinary domain, where computer science and mathematics play crucial roles, complemented with human-technology interaction, business models and operations management expertise and skills. Link to the [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/special-masters-tracks/data-science-in-engineering/dsie-track-of-computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/mastertrack-data-science-in-engineering/)

Admission DSiE in general

Admissions to the DSiE MSc requires basic working knowledge and skills in the following subjects, as acquired in approved bachelors level coursework:

* logic and set theory (2ITS60),
* linear algebra (2DBI00),
* Data modeling and databases (2ID50),
* Probability and Statistics (2DI90)
* Data structures (2IL50)
* Recommended: 2IIG0 Data mining and machine learning OR JBI030 Data Mining

PT-ICT students take:

* Linear Algebra (2DBI00) Q4-E level 1
* Data Structures (2IL50) Q3-B (level 2)
* Probability and Statistics (2DI90) Q4-C (level-2)
* 2IIG0 Data Mining and Machine Learning Q2-C (level-3)

*While there are no strict requirements, the course assumes that the students have followed the following courses: 2DBI00: Linear Algebra and Applications; 2IPC0 (Programming Methods); 2ILC0 (Algorithms); 2DI90 (Probability and statistics*

* OR JBI030 Data Mining Q3-E (level-2)

**How can you organize these courses in your PT-ICT program:**

You take 3 out of these 4 courses and use them as your technical package of 15 ects. You still can ask admission if you want, because you miss not more than 3 courses for direct admission. The 1 remaining course will become part of your master program in case you want to do this master as a mandatory elective, called homologation course. (Or you take the fourth course as a single elective in your bachelor elective space).

**MSc Computer Science and Engineering (CSE)**

The Master program in Computer Science and Engineering (CSE) gives a broad view of computer science from both a scientific and an engineering perspective and provides ample opportunities for specialization. The program offers three different streams: Software Science, Systems Science, and Web Science and the possibility to follow a program partly outside these streams, for instance to prepare for getting a teaching degree. Each stream has a core program of five courses. There is a large list of stream electives from which you should choose some courses to prepare for your master project. There is also ample room in the program to choose electives from outside your stream. Apart from the three streams there are also two special tracks: Data Science in Engineering and Information Security Technology.

Links to [digital study guide](https://studiegids.tue.nl/opleidingen/graduate-school/masters-programs/computer-science-and-engineering/?L=) and [TU/e site](https://www.tue.nl/en/education/graduate-school/master-computer-science-and-engineering/).

Admission to CSE in general

* 2WBB0, Calculus
* 2IT60, Logic and Set Theory
* 2IP90/JBI010, Programming
* 2ID50, Data modeling and databases OR JBI050 Data management for data analytics
* 2DBI00 Linear algebra and applications
* 2IPC0, Programming methods
* 2IL50, Data structures (ideally should be followed by 2ILC0 Algorithms)
* 2IT90, Automata, language theory and complexity
* 2IIG0, Data mining and machine learning OR JBI030 Data Mining

PT-ICT students take:

* Linear Algebra (2DBI00) Q4-E level 1
* Programming methods (2IPC0) Q2-b Level 3
* Data Structures (2IL50) Q3-B (level 2)
* Automata, language theory and complexity (2IT90) Q1-B level 2
* Data Mining (JBI030) Q3-E level 2 or Machine Learning (2IIG0), Q2-C level 3

**Two examples how you can organize these courses in your PT-ICT program:**

1. You take all 5 courses and you can apply for direct admission to DSAI, if you want. These 5 courses you can also use as the 15 plus 10 ects coherent packages you need in your electives.
2. You take 3 out of these 5 courses and use them as your technical package of 15 ects. You still can ask admission if you want, because you miss not more than 3 courses for direct admission. The 2 remaining courses will become part of your master program in case you want to do this master: 2 mandatory electives, called homologation courses.

NB Two related courses that fit nicely in CSE but are not strictly recommended:

* 2IT80 Introduction discrete structures Q2-E level 1
* 2IX20 Software Specification Q3-E level 3

**Overview of relevant packages on the A-Z page**

**Remark in advance**

You also can take the standard ICT-packages listed below. These are well defined packages.

Disadvantages could be:

* These packages as such mostly do not give admission to an ICT master (if you would want this)
* These packages mostly have less courses than the lists of premaster courses described above. When you can choose 3 courses out of 5, this probably gives more flexibility in planning your bachelor than when you take 3 specified courses from a standard package.

[Computer Science Essentials](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Computer_science_essentials.pdf). 2IP90 Programming and 2ID50 Data modeling and databases are already part of the PT-ICT track. If you choose this package, this counts as 10 ects, you do not meet the requirement of 15 ects technical courses yet:

* + 2IL50 Data structures and
	+ 2ITX0 Applied Logic Q2-D (level 1).
	+ In addition, students could take 2IT80 before 2IL50 and/or 2IT90 after 2IL50.
	+ *2IO90 DBL Algorithms (course last time in 2019-2020).*

[Analysis of information systems for Industrial Engineering](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/AnalysisOfInfSystems-ie-sept2019.pdf), an in-depth package of four courses.

Analysis of information, data, and knowledge is increasingly important, with broad application across science, engineering, society, and industry. To tackle these challenges, knowledge and skills in the management, mining, and analysis of (big) data collections is necessary. This elective package provides deeper study of the foundations and applications of analysis of data and information systems.

* + JBI100 Visualization, Q2-D level 2
	+ 2IIG0 Data Mining/Machine Learning, Q2-C level 3
	+ 2IOI0 DBL Process mining Q3-C level 2
	+ 2ID70 Data-intensive systems and applications Q3-D level 3 (2IP90, 2IL50 en 2ID50 recommended prior knowledge; affinity with learning new programming languages)

[Interactive Intelligent Systems](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Interactive_intelligent_systems_2016-2017.pdf)

* + 2ID90 Artificial Intelligence (the second course) is offered in 2019-2020 for the last time. The complete package cannot be taken anymore.
	+ 2IOE0 DBL (the third course) can only be taken if both 2IV60 and 2ID90 are completed.
	+ 2IV60 Computer Graphics remains a good free elective. Please note that linear algebra (2DBI00 or 2DE20) is required prior knowledge.
	+ 2IIG0 Data Mining and Machine Learning is a new free elective that can be taken; 2IPC0 (Programming Methods); 2ILC0 (Algorithms) may be necessary/helpful.
	+ In 2021-2022 a new second course will be developed in the area of Software; the DBL will be updated based on that new course and the new complete package will be launched by then.

[Data Science for IE&IS](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/JADS%20Coherent%20package%20voor%20BSc%20TBK%20en%20PT%202019.pdf)

This coherent package provides students with the basic knowledge on data science including programming, databases and machine learning techniques. This coherent package largely covers the requirements on data science courses necessary for the direct admission of students majoring Industrial Engineering or Innovation Sciences to the master “Data Science and Entrepreneurship” in JADS, Den Bosch. JADS is the Joint Graduate School of Tilburg University and Eindhoven University of Technology (see [www.jads.nl](http://www.jads.nl) for more information).

1. JBI020 Foundations of Computing Q2-E level 2
2. JBI030 Data Mining Q3-E level 2

If you choose this package, this counts as 10 ects, you do not meet the requirement of 15 ects technical courses yet.

[Data modelling Foundations](https://assets.studiegids.tue.nl/fileadmin/content/centrale_content/Bachelor_College/Vrije_Keuzeruimte/AZ_Keuzepakketten/Data%20Modeling%20Foundations%202019.pdf)

This elective package is for students in the bachelor program Data Science and other programs (except the bachelor program Computer Science), who are interested in the master program Data Science in Engineering (DSiE). The courses in this package offer required and highly recommended prior knowledge for enrollment in this master program. Students are admissible in the master program DSiE if they have successfully completed the packages (1) Data modeling foundations and (2) Computer Science for Data Science.

1. Linear algebra and applications (2DBI00), Q4(E) level 1
2. 2ID70 Data-intensive systems and applications Q3-D level 3 (2IP90, 2IL50 en 2ID50 recommended prior knowledge; affinity with learning new programming languages)

If you choose this package, this counts as 10 ects, you do not meet the requirement of 15 ects technical courses yet. A combination with Data Science for IEIS (JBI020 and JBI030) and Computer Science for Data Science (2IL50 and JBI040) fits well.

**Individual electives**

* + 2IV60 Computer Graphics remains a good free elective. Please note that linear algebra (2DBI00 or 2DE20) is required prior knowledge.
	+ 2IT80 Introduction discrete structures Q2-E level 1.
	+ 2IX20 Software Specification Q3-E level 3.
	+ 2IIG0 Data Mining and Machine Learning is a new free elective that can be taken, Q2-C level 3. 2IPC0 (Programming Methods); 2ILC0 (Algorithms) may be necessary/helpful.
	+ 2IS60 App programming for the last time in 2018-2019. Course is replaced by 2IS50 Software Development for Engineers, a follow-up course of 2IAB0 Data Analytics for Engineers.
	+ 2IS50 Software Development for Engineers is not allowed in combination with 2IP90 Programming. Here you can find the complete list: [overlap courses.](https://educationguide.tue.nl/programs/bachelor-college/elective-courses/overlap-courses/)

**Appendix 1 – Overview**



**Appendix 2 – J-codes**

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| --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Q** | **Technical Y/N** |
| JBC000 | Cognitive Science 1 | 3 | No |
| JBC090 | Cognitive Science 2 | 2 | No |
| JBE140 | Business Insights | 1 | No |
| JBE150 | Start-ups | 2 | No |
| JBG000 | Data Science Ethics | 4 | No |
| JBG010 | Perspectives on Data Science | 1 | No |
| JBL110 | Innovation and regulation | 4 | No |
| JBL120 | Law and data science | 1 | No |
| JBL130 | Understanding the Information Society | 2 | No |
| JBM040 | Business analytics | 2 | No |
| JBM110 | Firm's Lifecycle | 3 | No |
| JBM120 | Business Contracting | 4 | No |
| JBM130 | Entrepreneurship and Finance | 1 | No |
| JBM140 | Independent and corporate entrepreneurship | 2 | No |
| JBM160 | Data Science& Entrepreneurship in action | 4 | No |
| JBG030 | DBL Data Challenge | 4 | Yes |
| JBI020 | Foundations of computing | 2 | Yes |
| JBI030 | Data Mining | 3 | Yes |
| JBI040 | Algorithmic Aspects of Data Analysis | 4 | Yes |
| JBI050 | Data management for data analytics | 2 | Yes |
| JBI100 | Visualization | 2 | Yes |
| JBM010 | Data Statistics | 2 | Yes |
| JBM020 | Data Science research methods | 4 | Yes |
| JBM050 | Statistical computing | 4 | Yes |
| JBM200 | Generalized linear statistical models | 3 | Yes |
| JBM210  | Survival and Reliability Analysis | 1 | Yes |
| JBM220 | Multivariate Data Analysis | 4 | Yes |