

# Database Engineering

## Module book

2022-2023  
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# Foreword

In this module, you will learn to design a database and apply it in the PHP programming language. Databases are programmes that store and make data available. Many programmes use a database. You yourself probably use databases on a daily basis. When you withdraw money from an ATM, you consult the bank's database, when you visit websites on the Internet, you consult a database where (among other things) page texts are stored. When you apply for a new passport, you undoubtedly consult a database containing personal data, et cetera. Databases are actually the basis of any information system.

In this module, you will learn how to design your own database using the relational model. Besides designing a database, you will learn to query the data in the database using Structured Query Language (SQL). The knowledge and skills you gain in this module will be applied in the period 2 project.

The study load for this module is 168 hours (6 EC).

From the various methodologies applied at NHL Stenden University of Applied Sciences, the methodology of the "Database Engineering" module has been shown in the past to be the most suitable method for a beginning developer. Due to student evaluations, the programme has been modified to allow more time for testing the cognitive knowledge acquired.

Gerjan van Oenen, Rob Smit and Jaqueline Berghout

Emmen, 10-10-2022

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# 1 Introduction

In this module, we are introduced to the fundamentals of database systems. As a starting point, we use relational database systems: these are systems, which are based on the relational data model. There is a theoretical part that is carried out both individually and in groups.

Within system development, one phase is the design phase where the functional wishes and requirements are expressed in a Functional Design. This will be studied in the "Information Management" module. One of the components in this Functional Design is the design of a data model, usually represented graphically, in an Entity Relationship Diagram (ERD). This will be covered in this module.

The database knowledge gained is applied in a PHP website.

## **Characteristic professional situation**

Info Support provides solid and innovative software solutions that support organisations in achieving their business objectives. We achieve this by continuously gathering, applying and sharing knowledge with talented and passionate professionals. We secure our market knowledge through our business units from which we operate.

## **Junior Databasebeheerder**

As a Junior Database Administrator, you will be assigned to a team responsible for managing databases in a business critical environment. In this position, you are responsible for installing and managing database management systems. You design and implement (physical) databases. Furthermore, as Database Manager you are responsible for the optimal functioning of databases, given agreed performance characteristics (monitoring, optimisation and tuning). Furthermore, you are increasingly able to support application developers. You are already certified or wish to become certified in the field of database management.

## 1.1 Module theme

In this module, we are introduced to the fundamentals of database systems. As a starting point, we use relational database systems: these are systems, which are based on the relational data model. There is a theoretical part that is carried out both individually and in groups. Within system development, one phase is the design phase in which the functional wishes and requirements are expressed in a Functional Design.

## 1.2 Learning outcomes

Upon successful completion of this module, the student will be able to describe the following terms:

- > A database and the global architecture of a database;
- > The operation of a database management system;
- > All concepts from the relational model: attribute, domain, tuple, relation, candidate key, primary key and foreign key. These concepts can be connected by the student to the concepts from the relational databases: table, row, column, primary key, foreign key, constraint;
- > Integrity of a database;
- > The concepts of null value, redundancy, functional dependence, normalisation.

Furthermore, the student is able to:

- > Classify the nature of relationships;
- > Create a normalised database design;
- > Implement the following in SQL:
  - > Create a database (using data definition language)
  - > Mutations (data manipulation language);
  - > Queries (data query language). This includes:
    - Use of functions;
    - Possibility of grouping;
    - Association of tables (join).

## Realise

The student realises in a structured and individual way, based on a design, a professional product belonging to the software. The realised professional product meets the given standards, so that the student delivers a realisation that offers a solution to various (IT) problems.

During the Database Engineering module, the following requirements are addressed:

- > Work continues from the previous module on the following requirements within an application.
  - *Uses variables.*
  - *Uses conditional statements.*
  - *Uses loops.*
  - *Uses a web user interface.*
  - *Programming is done in a safe and clean manner using given code conventions and given standards.*
- > *The following items are added as new requirements:*
  - *Interaction with the database meets the following requirements:*
    - *Transactions (queries) are performed from the software system towards the database.*
    - *Interactions with a database are performed in a secure manner.*
    - *The interaction is based on Structured Query Language (SQL).*

### 1.3 Prior knowledge

The prior knowledge required to take the module is listed in the most recent Teaching Descriptions of the TER.

### 1.4 Conventions

The conventions to be used regarding naming and format of the programme code can be found on Blackboard within ICT general.

### 1.5 Version

Version	Date	Author	Description
1.0	10-10-2022	Jaqueline Berghout	First version

### 1.6 Attendance at guest lecture, excursion or workshop

During the implementation of this module, there is the possibility of scheduling a guest lecture, excursion, or workshop. This is mandatory. In the unlikely event that the student is unable to attend, a substitute assignment will be provided.



## 2 Assessment

To assess whether you have achieved the objectives of this module, an individual final test will be used.

Table 2.1 provides an overview of the final test with relevant information on norms, marks and credits.

Assessment will be done by means of an assessment form (Scoring Rubrics), which can be found in Annex 7.1.

This module is assessed with a passing grade if the standard is met, which is determined using the Scoring Rubrics in Appendix 7.1.

Table 2.1 Overview testing

Method	Max. points	Norm-%	Norm in points	Credits	Deadline	Resit
Exam	100	55	55	6	Week 9	Period 3
Total	100	55	55	6	-	-

### 2.1 Assessment of practical test

The final assessment is a practical test in which the student has to (complete) a web application at the computer. This application must use a working database. This practical test will have the same level of difficulty as the material covered and will have to be completed within the allotted time.

For this final test, students may use the prescribed literature, which can be found in chapter 5.

**Other means, e.g. Internet, are not allowed and not available.**

The assessment of the practical test will be done using the assessment form (Scoring Rubrics), which can be found in appendix 7.1. This module will be assessed with a pass mark if the standard is met for the practical test.

## 2.2 Active participation

Students should provide themselves with the necessary preparation for both lectures and tutorials. The assignments can be provided with feedback by the lecturers in the same week of the programme or in the following week, provided the student makes a claim for this. If the student wishes to claim feedback after this period, this must be done in consultation with the lecturer.

## 2.3 Module resit

Students who fail the practical test can take a resit at the end of the succeeding term.

## 3 Programme

This module contains a number of (weekly) lectures and tutorials. During the practical lectures, the student has the opportunity to discuss problems with the assignments with the lecturers and also to sign off assignments.

The whole thing will conclude with a practical test.

Please refer to the Information Guide.

### 3.1 College forms

The different college types are described below.

#### 3.1.1 Lectures

During the lectures, which are interactive in nature, various aspects of the subject 'Database Engineering' are discussed. This could be, for instance, an explanation of SQL queries, the steps of the normalisation process or the explanation of algorithms. Regularly, a specific (programming) problem will be discussed and the teacher will demonstrate/explain its solution step by step.

#### 3.1.2 Tutorials

During the tutorials, the student has the opportunity to actively participate in the assignment of that week. The student has the opportunity to obtain feedback on the parts of the corresponding feedback. There is the possibility to obtain this feedback in the following week. However, it is not possible that a student requests feedback at the end of the period for an assignment from the first few weeks. However, this can be deviated from in consultation with the teacher.

Important:

- The lectures and tutorials must be prepared in advance.
- The teacher is available for parts of the seminar.

#### 3.1.3 Response lectures

During response lectures, the student has the opportunity to go through the assignments with fellow students, under the guidance of a teacher. This gives the student the opportunity to discuss problems and to discover and correct any errors in his / her reasoning. In addition, the teacher can use questions to determine whether the learning objectives in the relevant assignments have indeed been achieved. During a response lecture, the student is expected to have an active, critical attitude and good preparation.

## 3.2 Programme overview

In the table below you can find an overview of the weekly activities.

Week	Task. Nr.	Study activity
1	3.3.1	Introduction lecture Lecture Database (DQL SELECT)
	3.3.2	Lecture: PHP (Arrays and validation)
	3.3.3	Tutorial Database Engineering [2x]
2	3.3.4	Lecture Database (ERD, DML INSERT/UPDATE)
	3.3.5	Lecture PHP (File uploading and File I/O)
	3.3.6	Tutorial Database Engineering [2x]
3	3.3.7	Lecture Database (DQL, DML INNER/LEFT/RIGHT JOIN)
	3.3.8	Lecture PHP (Sessions and Cookies)
	3.3.9	Tutorial Database Engineering [2x]
4	3.3.10	Lecture Database (DQL, DML, Subquery)
	3.3.11	Lecture PHP (Databases Insert, Select and Update)
	3.3.12	Tutorial Database Engineering [2x]
5	3.3.13	Lecture Database (Create Tables)
	3.3.14	Lecture PHP (Databases Insert, Select and Update)
	3.3.15	Tutorial Database Engineering [2x]
6	3.3.16	Lecture Database (Normalising)
	3.3.17	Lecture PHP (Cryptography, hashing and login systems)
	3.3.18	Tutorial Database Engineering [2x]
7	3.3.19	Lecture Database (Student input)
	3.3.20	Lecture PHP (Database install scripts)
	3.3.21	Tutorial Database Engineering [2x]
8	3.3.22	Lecture Database (Student Input)
	3.3.23	Lecture: PHP (Optional: OOPHP)
	3.3.24	Tutorial Database Engineering [2x]
9	3.3.25	Exam: Database Engineering

### 3.3 Weekly programme's

#### 3.3.1 Lecture: Introduction + Database

Week	1
Work format	Lecture
Time	1 hour
Lesson objectives	<p>The student obtains an overview of the content of the module "Database Engineering".</p> <p>During the introduction we discuss the structure of the course. Then the basic terms are introduced and explained. Data Query is started by discussing the Select query.</p>
Content	<ul style="list-style-type: none"><li>• Meaning of the terms Database, DBMS, SQL</li><li>• Introduction to keys, both primary and foreign.</li><li>• SELECT instruction</li></ul>
Preparations/ Individual assignments:	<p>Install Xampp/Docker and an IDE of your choice</p> <p>Chapter 1 – 1.3 to 1.12</p> <p>Chapter 2 – 2.17 to 2.39</p>

#### 3.3.2 Lecture: PHP

Week	1
Work format	Lecture
Time	1 hour
Lesson objectives	During this lecture, advanced arrays will be explained and validation will be discussed further.
Content	Arrays & validation
Preparations/ Individual assignments:	Install Xampp/Docker and an IDE of your choice

### 3.3.3 Tutorial Database Engineering [2x]

Week	1
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this tutorial it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	Install Xampp/Docker and IDE at the student's choice. <b>Execution and completion of assignments week 1 Database Engineering</b>

### 3.3.4 Lecture: Database

Week	2
Work format	Lecture
Time	1 hour
Lesson objectives	During the lecture, all items within an <i>Entity-Relation Diagram</i> will be discussed and the theory behind setting up an ERD will be discussed. Furthermore, the different modelling techniques for designing ERDs are examined. Data Manipulation Language is covered by discussing Insert and Update query.
Content	<ul style="list-style-type: none"><li>• UPDATE instruction</li><li>• INSERT instruction</li><li>• Entities, Relations and attributes</li><li>• Recognizing an entity</li><li>• Classifying relations</li><li>• Primary and Foreign Keys</li><li>• UML vs Crows Foot</li></ul>
Preparations/ Individual assignments:	Chapter 5 (p228-p242) Tutorial assignment: ERD Case Annex 2 ERD case extra A to H.

### 3.3.5 Lecture: PHP

Week	2
Work format	Lecture
Time	1 hour
Lesson objectives	During this lecture an explanation will be given on how files can be uploaded to a server using .PHP. In addition, it explains how you can read and write files on a server with PHP.
Content	File uploading & File I/O
Preparations/ Individual assignments:	The knowledge of Arrays from week 1

### 3.3.6 Tutorial Database Engineering [2x]

Week	2
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this tutorial it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 2 Database Engineering</b>

### 3.3.7 Lecture: Database

Week	3
Work format	Lecture
Time	90 min
Lesson objectives	<p>By means of a JOIN it is possible to obtain data from multiple tables. Something that is not possible with a SELECT alone. We spend time on the INNER, LEFT and RIGHT JOIN to understand the differences. Furthermore, the way to establish a JOIN with the WHERE clause is being looked at.</p> <p>After the JOIN, the Subquery is looked at where a SELECT is called within a SELECT. This can have multiple benefits for the creative SQL developer.</p>
Content	<ul style="list-style-type: none"><li>• LEFT, RIGHT and INNER JOIN</li><li>• FROM x, y WHERE</li><li>• SELECT</li></ul>
Preparations/ Individual assignments:	Chapter 2 (p119-p137)

### 3.3.8 Lecture: PHP

Week	3
Work format	Lecture
Time	1 hour
Lesson objectives	<p>During this lecture an explanation will be given on what cookies and sessions are, what the difference is between them and when you can apply them.</p>
Content	Cookies & sessions
Preparations/ Individual assignments:	



### 3.3.9 Tutorial Database Engineering [2x]

Week	3
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 3 Database Engineering</b>

### 3.3.10 Lecture: Database

Week	4
Work format	Lecture
Time	1 hour
Lesson objectives	In this lecture we will combine the knowledge and skills of the first lecture with the skills of this week. An extensive dataset will be used to provide complex query questions with an answer. In this seminar, the focus is on the Subquery.
Content	<ul style="list-style-type: none"><li>• LEFT, RIGHT and INNER JOIN</li><li>• FROM x, y WHERE</li><li>• SELECT</li></ul>
Preparations/ Individual assignments:	Seminar assignment: Model Cars – Full Marcia's Dry Cleaning A t/m Q Morgan Importing A t/m Q

### 3.3.11 Lecture: PHP

Week	4
Work format	Lecture
Time	1 hour
Lesson objectives	During this lecture an explanation will be given on how you can extract data from a database and put it in by means of PHP and SQL.
Content	Prepared statements & SQL
Preparations/ Individual assignments:	

### 3.3.12 Tutorial Database Engineering [2x]

Week	4
Work format	Tutorial
Time	2 hour
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	Execution and completion of assignments week 4 Database Engineering

### 3.3.13 Lecture: Database

Week	5
Work format	Lecture
Time	1 hour
Lesson objectives	<p>During this lecture, another branch of SQL will be discussed: Data Definition Language.</p> <p>We look at the create table syntax and how to apply it.</p> <p>Furthermore, we look at the integrity of a database and how we can promote it when creating it.</p>
Content	<ul style="list-style-type: none"><li>• Create Table</li><li>• Constraint</li><li>• Default</li><li>• On UPDATE/ON DELETE</li><li>• CASCADE/NO ACTION/[RESTRICT]/[SET DEFAULT]/[SET NULL]</li></ul>
Preparations/ Individual assignments:	<p>Chapter 6</p> <p>Chapter 7 (p334-p350)</p> <p>Chapter 7 – 7.7 to 7.27</p>

### 3.3.14 Lecture: PHP

Week	5
Work format	Lecture
Time	1 hour
Lesson objectives	<p>During this lecture, attention will once again be paid to how you can extract data from a database and put it in by means of PHP and SQL. There is also more room for practical examples.</p>
Content	PHP & SQL.
Preparations/ Individual assignments:	

### 3.3.15 tutorial Database Engineering [2x]

Week	5
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 5 Database Engineering</b>

### 3.3.16 Lecture: Database

Week	6
Work format	Lecture
Time	1 hour
Lesson objectives	In this lecture, the different phases of the standardisation process are discussed. All forms are discussed in detail and the process from ONV to 3NF is demonstrated.
Content	<ul style="list-style-type: none"><li>• Normalising</li><li>• ONF, 1NF, 2NF and 3NF</li><li>• Repeating groups</li><li>• Parallel repeating groups</li><li>• Nested repeating groups</li><li>• Functional dependency</li><li>• Determinant</li></ul> <i>The key, the whole key and nothing but the key</i>
Preparations/ Individual assignments:	Chapter 3

### 3.3.17 Lecture: PHP

Week	6
Work format	Lecture
Time	1 hour
Lesson objectives	During this lecture explanation will be given on what cryptography and hashing is. In addition, it is explained how you can make a good login system by means of cryptography and hashing.
Content	Cryptography, hashing & login systems
Preparations/ Individual assignments:	

### 3.3.18 Tutorial Database Engineering [2x]

Week	6
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 6 Database Engineering</b>

### 3.3.19 Lecture: Database

Week	7
Work format	Lecture
Time	1 hour
Lesson objectives	-
Content	It is possible for the students to indicate a topic here that needs repetition. All previous topics can be discussed again and provided with a demonstration. It is also possible to request an extra-curricular topic.
Preparations/ Individual assignments:	Bringing up a subject for repetition or in-dept analysis

### 3.3.20 Lecture: PHP

Week	7
Work format	Lecture
Time	1 hour
Lesson objectives	This lecture will explain how you can use PHP to create a database to create an installation script.
Content	
Preparations/ Individual assignments:	

### 3.3.21 Tutorial Database Engineering [2x]

Week	7
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 7 Database Engineering</b>

### 3.3.22 Lecture: Database

Week	8
Work format	Lecture
Time	1 hour
Lesson objectives	It is possible for the students to indicate a topic here that needs repetition. All previous topics can be discussed again and provided with a demonstration. It is also possible to request an extra-curricular topic.
Content	Bringing up a subject for repetition or in-dept analysis
Preparations/ Individual assignments:	

### 3.3.23 Lecture: PHP

Week	8
Work format	Lecture
Time	1 hour
Lesson objectives	During this optional lecture, a start is made with the concept of "object-oriented programming".
Content	Object-oriented PHP
Preparations/ Individual assignments:	

### 3.3.24 Tutorial Database Engineering [2x]

Week	8
Work format	Tutorial
Time	2 hours
Lesson objectives	The student uses this time to ask questions or complete the corresponding assignments.
Content	During this seminar it is possible for the student to process and apply the material of the previous lectures. Assignments are assigned that the student must complete in order to gain the necessary skills.
Preparations/ Individual assignments:	<b>Execution and completion of assignments week 5 Database Engineering</b>

### 3.3.19 Final exam Database Engineering

Week	9.
Work format	Final exam.
Time	3 hours.
Lesson objectives	The student must complete a number of assignments within the agreed time limit. The assignments will be based on the teaching material from the previous weeks.
Content	-
Preparations/ Individual assignments:	-



## 4 Structure & Organisation

The diagram below gives an overview of all contact hours in this module.

In addition, students are expected to plan their own (project) meetings where they can work on the assignments. This also applies to the time that the student needs to prepare and make (individual) assignments. This schedule also gives a good overview of the expected study load per student.

Table 4. 1 Student contact hours (SCH) and Study Load Hours (SLH) per week:

	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH	SCH	SLH
Lecture	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	0	0	14	48
Tutorial	4	12	4	12	4	12	4	12	4	12	4	12	4	12	4	12	0	0	28	96
Exam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
Self study	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Totals study activity</b>	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18	0	3	42	147
Extra curricular activities																			0	21
<b>Grand total</b>																			42	168

SCH = Student contact hours (45 minutes)

SLH = Study load hours (60 minutes)

## 5 Literature / software

The literature and software required to successfully complete the course are listed below.

### 5.1 (Compulsory) Curriculum

1. This module book
  - > Boek: Database Processing Edition 14
  - Author(s): David M. Kroenke, David J. Auer
  - Publisher: Pearson
  - ISBN-13: 9781292107639

### 5.2 Reference work

- > Blackboard
- For information and assignments
- > <http://sqlzoo.net/>
- SQL tutorial
- > <http://sqlcourse.com>
- SQL tutorial
- > <http://www.w3schools.com/sql>
- SQL tutorial

### 5.3 Software

- > PhpMyAdmin: <http://www.phpmyadmin.net/>
- > HeidiSQL: <http://www.heidisql.com/>
- > MySQL Workbench: <http://wb.mysql.com/>
- > Visual Studio Code: <https://code.visualstudio.com/>
- > PHP Storm: <https://www.jetbrains.com/phpstorm/>

### 5.4 Example Programs

Example programs can be found under the course on Blackboard.

## 6 Module evaluation

The module will be evaluated by means of a questionnaire at the end of the module. This questionnaire contains all parts of the module including organisational aspects, content, quality of teaching staff, etc.

We kindly ask you to participate in this evaluation. The results of this evaluation will be used to improve the next version of this module.

## 7 Annexes

### 7.1 Scoring Rubrics

The scoring rubrics can be found on Blackboard in the course "Database Engineering".

