

# INST733 - Database Design - Section ML01 - Spring 2023

## Syllabus V2 (02/04/2023)

*This syllabus is subject to change throughout the semester. Check Canvas (ELMS) for the current version.*

<b>Instructors:</b>	Vedat G. Diker	Pamela Duffy	<b>TA:</b> Sagar Chand
<b>Office:</b>	PTX 1117E	PTX 2019F	<b>Class meeting time &amp; place:</b>
<b>Phone:</b>	(301) 405-9814*	(301)405-0860*	Thursday 2:00-4:45pm
<b>E-mail:</b>	via Canvas messaging	via Canvas messaging	HBK 0302H
<b>Office Hours:</b>	By appointment	By appointment	

\* only when absolutely necessary

### Catalog Description:

Principles of user-oriented database design. Requirements analysis. Data modeling. Data integrity and security and multi-user databases. Implementing an information system using a database management system (DBMS).

### Extended Description:

This course focuses on approaches to and methods for designing relational and contemporary non-relational (NoSQL) databases. After almost half a century of development, and challenges from various competing paradigms, relational databases remain to be the major paradigm for data persistence. A high-quality relational database can help leverage an organization's data and information assets for better fulfillment of its mission. On the other hand, a poorly designed database can complicate even the simplest data-driven functions within the organization. This course covers principles and methods for logical and physical database design, the theoretical considerations behind the relational paradigm, as well as SQL, a language for maintaining relational databases and managing data held in relational databases. Once relational database design and administration fundamentals are established, the focus of the course will move to limitations posed by relational databases, and approaches to addressing those limitations within and beyond the relational paradigm, including some of the NoSQL solutions developed over the last decade.

### Learning Outcomes:

After completing this course, the students will be able to:

- define fundamental concepts in relational databases,
- develop a logical database design,
- develop entity-relationship diagrams,

- normalize relational database tables,
- develop a physical database based on a logical design,
- perform CRUD (create, read, update, delete) operations on relational databases

### **Elements of the Course:**

**Active Participation:** The course will involve in-class discussions, as well as in-class exercises. The students are expected to come to class prepared and participate actively. Participation is necessary in order to excel at this course. However, if you are not feeling well, or you suspect you may have a communicable health condition, please refrain from coming to class sessions; we will accommodate you as needed. If you anticipate missing a session, email the instructors ahead of time, or contact us soon afterwards.

**Preparation Exercises/Questions:** Most weeks, a number of introductory exercises will be posed, which the students are expected to work on in advance of each class session. These are a combination of practical exercises that involve writing queries or other types of code, and conceptual questions on the topics being covered that week. Students are expected to work on these questions as they prepare for each class. The questions will help students steer their coverage of the week's content. Students are not expected to submit their questions for review and grading; however, they should feel free to contact the instructors or TA for help and input with the questions that they are not able to answer conclusively. Some of the exercise questions, or their derivatives, may be used as assignment questions or discussion topics.

**Assignments:** Some modules will involve assignments that contain 2-3 questions focusing on practical tasks such as developing queries, writing procedural code, developing an entity-relationship diagram, or normalizing database tables. Students are expected to **work on these assignments individually, and not receive any help from classmates or other individuals.** Seeking help from the instructors or TA is permitted and advised. If any of the assignment due dates is a holiday for you, please inform the instructors in advance, so an alternate due date can be set for you. Students' work on and solutions for the assignments will be submitted via Canvas (ELMS) and will be graded. Assignment feedback and grades will be posted on Canvas, as well.

**Project:** Students will work as pairs on a semester-long project where they will develop a logical design for a small-scale, non-trivial relational database, and subsequently implement the design in a

physical database. Once the logical and physical design is completed, students will populate their databases with sample data and run CRUD operations on their databases. Students will choose their topic in consultation with the instructors. Project work will begin only after the topic, the scope and other particulars of the project are fully and explicitly approved by the instructors. Students will submit the project deliverables via Canvas (ELMS) for review and grading. Project feedback and grades will be posted on Canvas, as well.

The following stages of the project will be evaluated and graded. The first stage (proposal) will be evaluated through a separate submission earlier in the semester, and the rest will be evaluated as part of the final submission towards the end of the semester:

- Proposal [**separate submission, earlier in the semester**]
- Logical design (including an E-R diagram, and normalization as necessary),
- Physical design (including data type choices and queries for building the physical database),
- Sample data and CRUD operations.
- Feasibility analysis of implementing the database on an alternative platform/paradigm.
- Project diary and report (Students will keep a log/diary of their activities on the database, including the challenges faced and how they were solved. A final report will summarize the overall project. The log/diary will be included in the report as a section of an appendix).

The database and the report will be of professional quality, which could be used as the basis for an actual relational database in an actual organization. Details about the expectations for the project and submission deadlines will be given on the course website on Canvas.

**Research and Presentation Topics:** Each project team will research an advanced database design and management topic, write a brief (4-5 pages) report about what they have learned, and give a presentation to share their findings with the class. This can be in the form of developing a small-scale sample database using an alternative database technology, such a graph or document database.

**Project Reflection:** This is an opportunity for each team member to reflect on the semester long team project. Each student will make a separate submission by answering a few questions about the project, and other aspects of the course, reflecting on their learning experience.

**Grading:**

Preparation Exercises/Questions	0% [not graded]
Assignments	30%
Project - Proposal	5%
Project - Final Submission	40%
(See project final submission rubric for details of point breakdown)	
Research and Presentation Topics	20%
Course Reflection	5%

**Resources:*****Books (Required):***

(Electronic versions of these books might be available for purchase/download.  
A few chapters from each book will be made available on electronic reserves).

- **Murach's MySQL, (2<sup>nd</sup> Edition OR 3<sup>rd</sup> Edition)**, Joel Murach,  
Mike Murach & Associates. ISBN: 978-1890774820 OR 978-1943872367
- **Designing Data Intensive Applications**, Martin Kleppmann,  
O'Reilly Media. ISBN: 978-1449373320

***Books (Recommended):***

(Electronic versions of these books might be available for purchase/download.  
A few chapters from each book will be made available on electronic reserves).

- **SQL: Visual QuickStart Guide (3<sup>rd</sup> Edition)**, Chris Fehily,  
Peachpit Press. ISBN: 0321553578 / 978-0321553577
- **NoSQL Distilled**, Pramod J. Sadalage and Martin Fowler,  
Addison-Wesley. ISBN: 978-0321826626
- [For those interested in learning PostgreSQL, which is not formally covered in this course]  
**Practical SQL: A Beginner's Guide to Storytelling with Data**, Anthony DeBarros,  
No Starch Press. ISBN: 978-1593278274

*Additional readings and resources may be assigned as needed. Extra materials, if any, will be announced via ELMS/Canvas.*

***Required Software (You need both item 1 and item 2 below):***

- 1) **MySQL Community Server**, available at <http://dev.mysql.com/downloads>.
- 2) **MySQL Workbench**, also available at <http://dev.mysql.com/downloads>.

**We strongly recommend visiting the ELMS/Canvas course and watching the videos on the Installation Videos page before you start the installation process.**

Please install the required software on your computer at your earliest convenience. **You should complete installing the required software by the start of the second week/module of the course.** The instructors and TA will help you with installation as needed, but you are responsible for starting the process and getting in touch with the instructors or TA with any issues that may emerge during the installation process.

***A Computer (Required):***

For the best learning experience in this course, you must have continuous access to a computer that can run the software listed above. A computer running on any of the commonly used operating systems, Windows, MacOS or Linux, should be fine for this course, as long as it can run the two software applications listed above.

***Videos (Optional - Recommended):***

A variety of video courses and single videos will be recommended for students who are interested in reinforcing their learning with videos. Most of the videos will be made available through LinkedIn Learning (<https://www.linkedin.com/learning/login-ent>), Coursera (<https://www.coursera.org/>), and YouTube. UMD students have free access to LinkedIn Learning. Coursera videos will be chosen from among freely accessible courses.

***Optional Software:***

Students interested in learning PostgreSQL may wish to download PostgreSQL server and PgAdmin at <https://www.enterprisedb.com/downloads/postgres-postgresql-downloads>. Unlike MySQL, PostgreSQL is not formally covered in this course. If you do not have prior experience working with MySQL, you may wish to postpone exploring PostgreSQL until later in the semester or after you complete this course.

**Policy on Academic Misconduct**

Cases of academic misconduct will be referred to the Office of Student Conduct irrespective of scope and circumstances, as required by university rules and regulations. It is crucial to understand that the instructors do not have a choice of following other courses of actions in handling these cases. There are severe consequences of academic misconduct, some of which are permanent and reflected on the student's transcript. For details about procedures governing referrals and possible consequences visit <http://osc.umd.edu/OSC/Default.aspx>.

It is very important that you complete your own assignments, and do not share any files or other work. The best course of action to take when a student is having problems with an assignment question is to contact the instructors. The instructors will be happy to work with students while they work on the assignments.

**University of Maryland Code of Academic Integrity:**

"The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit <http://shc.umd.edu/SHC/Default.aspx>".

**Special Needs**

The University is legally obligated to provide appropriate accommodations for students with disabilities. UMD's Accessibility & Disability Service Office (ADS, <https://www.counseling.umd.edu/ads/>) works with students and faculty to address a variety of issues ranging from test anxiety to physical and psychological disabilities.

If a student or instructor believes that the student may have a disability, they should consult with ADS (301-314-7682 or [adsfrontdesk@umd.edu](mailto:adsfrontdesk@umd.edu)). Note that to receive accommodations, students must first have their disabilities documented by ADS. The office then prepares an Accommodation Letter for course instructors regarding needed accommodations. Students are responsible for presenting this letter to their instructors.

Students encountering psychological problems that hamper their course work are referred to the Counseling Center (301-314-7651 or <http://www.counseling.umd.edu/>) for expert help.

**Notice of Mandatory Reporting**

Notice of mandatory reporting of sexual assault, sexual harassment, interpersonal violence, and stalking: As faculty members, we are designated as a “Responsible University Employees,” and we must report all disclosures of sexual assault, sexual harassment, interpersonal violence, and stalking to UMD’s Title IX Coordinator per University Policy on Sexual Harassment and Other Sexual Misconduct.

If you wish to speak with someone confidentially, please contact one of UMD’s confidential resources, such as [CARE to Stop Violence](#) (located on the Ground Floor of the Health Center) at 301-741-3442 or the [Counseling Center](#) (located at the Shoemaker Building) at 301-314-7651.

You may also seek assistance or supportive measures from UMD’s Title IX Coordinator, Angela Nastase, by calling 301-405-1142, or emailing [titleIXcoordinator@umd.edu](mailto:titleIXcoordinator@umd.edu).

To view further information on the above, please visit the [Office of Civil Rights and Sexual Misconduct's](#) website at [ocrsm.umd.edu](http://ocrsm.umd.edu).

**Tentative Course Plan** (Subject to possible change during semester):

Wk.	Dates	Topics	Readings <sup>1</sup>	Other resources	Work due [Date due]
1	Jan. 26	Course introduction and logistics; Software installation and introduction; SQL introduction	<i>[MMSQL]</i> - <b>Ch.s 1, 2</b> [BDBD] - Ch. 10 [MDBM] - Ch. 6 [SQLVQS] - <i>Ch. 2 &amp; Ch. 3</i>	- XAMPP and MySQL Workbench Installation Videos  (see Canvas/ELMS for links)	---
2	Feb. 2	SQL: Read (*R**) operations; Joins; Relationship types; Primary and foreign keys; Project ideas	<i>[MMSQL]</i> - <b>Ch. 3 &amp; Ch. 4</b> [BDBD] - Ch. 9 [MDBM] - Ch. 7 <i>[SQLVQS]</i> - <i>Ch.s 4, 6, 7, 8</i>	LinkedIn: - Learning SQL Programming - SQL Essential Training - MySQL Essential Training  Coursera: - Introduction to SQL (Wk. 2)  (see Canvas/ELMS for links)	Installations [Wed, 2/1]
3	Feb. 9	SQL: Aggregate (summary) queries; Subqueries; Data types; Functions	<i>[MMSQL]</i> - <b>Ch.s 6, 7 &amp; Ch.s 8, 9</b> [SQLVQS] - Ch. 5		---
4	Feb. 16	SQL: Create, Update, Delete (C*UD) operations Views	<i>[MMSQL]</i> - <b>Ch.s 5, 12</b> [SQLVQS] - Ch.s 10, 13		Assignment 01 [Tue., 2/14]
5	Feb. 23	Stored program development; Stored procedures; Stored functions; Triggers; Events; Transactions	<i>[MMSQL]</i> - <b>Ch. 13</b> <i>[MMSQL]</i> - <b>Ch.s 14, 15, 16</b> [SQLCE] - Ch. 14		---
6	Mar. 2	Entity-relationship diagrams; Defining entities, attributes, and data types; Defining relationships	<i>[MMSQL]</i> - <b>Ch. 10</b> [ASQL] - Ch. 1 [DMDLD] - Ch. 2 [RDDCE] - Ch.s 4, 5 [SQLCE] - Ch. 1		Assignment 02 [Tue, 2/28]
7	Mar. 9	Normalization	[BDBD] - Ch. 8 [DMDLD] - Ch. 6 [RDDCE] - Ch. 6		Project Proposal [Tue, 3/7]

<sup>1</sup> Chapters in *italics* will not be available on electronic course reserves due to fair-use limitations. If you do not have a copy of the given book, you can safely skip those chapters, except chapters from the required books, which are shown in **bold**.



Wk.	Dates	Topics	Readings <sup>1</sup>	Other resources	Work due [Date due]
8	Mar. 16	Physical design principles; Indexes; Physical design via MySQL Workbench; Forward and reverse engineering	<i>[MMSQL]</i> - Ch. 11 [FDBMS] - Ch. 8 [MDBM] - Ch. 5 [PDBD] - Ch.s 1, 2 <i>[SQLVQS]</i> - Ch.s 11, 12		Assignment 03 [Tue, 3/14]
SPRING BREAK (March 19 - March 26)		Optional topics: Relational algebra; Relational theory	[DMDLD] - Ch. 1 [SQLCE] - Ch. 2 [SQLRT] - Ch.s 1, 2, 3		No work due
9	Mar. 30	Limitations of relational databases; New database paradigms; Data models	<b>[DDIA]</b> - Ch. 2 [NGDB] - Ch. 1 [NSQLD] - Ch.s 2, 3		Assignment 04 [Tue, 3/28]
10	Apr. 6	Graph databases	[NGDB] - Ch. 5 [NSQLMM] - Ch. 12 [SDBSW] - Ch. 6		Assignment 05 [Tue, 4/4]
11	Apr. 13	Document databases, Key-value databases	[NGDB] - Ch.s 4, 7 [NSQLMM] - Ch.s 3, 6 <i>[SDBSW]</i> - Ch.s 4, 8		Project Progress Report [Tue, 4/11]
12	Apr. 20	Column-family databases	[NGDB] - Ch. 6 [NSQLMM] - Ch. 9 [SDBSW] - Ch. 3		---
13	Apr. 27	Distribution models; Replication; Partitioning/Sharding; Consistency	<b>[DDIA]</b> - Ch.s 5, 6, 8, 9 [NGDB] - Ch. 8, 9 [NSQLD] - Ch.s 4, 5, 6		---
14	May 4	Derived data; Processing approaches; Data warehousing	<b>[DDIA]</b> - Ch.s 10, 11 [NSQLD] - Ch. 7 [NSQLMM] - Ch. 15		Final Project DB and Report [Tue, 5/9]
15	May 11	Course wrap-up	As needed		

<sup>1</sup> Chapters in *italics* will not be available on electronic course reserves due to fair-use limitations. If you do not have a copy of the given book, you can safely skip those chapters, except chapters from the required books, which are shown in **bold**.

## **Book Codes:**

**ASQL:** The Art of SQL [2006]

(S. Faroult, P. Robson) (O'Reilly Media - ISBN: 9780596008949)

**BDBD:** Beginning Database Design - 2<sup>nd</sup> Edition [2012]

(Clare Churcher) (Apress - ISBN: 9781430242093)

**DDIA:** Designing Data-Intensive Applications [2017]

(M. Kleppmann) (O'Reilly Media - ISBN: 9781449373320)

**DMDLD:** Database Modeling and Design: Logical Design - 5<sup>th</sup> Edition [2011]

(T. Teorey, S. Lightstone, T. Nadeau, H.V. Jagadish) (Morgan K. - ISBN: 9780123820204)

**FDBMS:** Fundamentals of Database Management Systems - 2<sup>nd</sup> Edition [2012]

(Mark L. Gillenson) (Wiley - ISBN: 9780470624708)

**MDBM:** Modern Database Management - 10<sup>th</sup> Edition [2011]

(Jeffrey A. Hoffer, V. Ramesh, Heikki Topi) (Prentice Hall - ISBN: 9780136088394)

**MMSQL:** Murach's MySQL - 2<sup>nd</sup> Edition [2015] (or use 3<sup>rd</sup> Edition [2019])

(Joel Murach) (Mike Murach and Associates - ISBN: 9781890774820)

**NGDB:** Next Generation Databases [2015]

(Guy Harrison) (Apress - ISBN: 9781484213308)

**NSQLD:** NoSQL Distilled [2013]

(Pramod J. Sadalage, Martin Fowler) (Addison Wesley - ISBN: 9780321826626)

**NSQLMM:** NoSQL for Mere Mortals [2015]

(Dan Sullivan) (Addison Wesley - ISBN: 9780134023212)

**PDBD:** Physical Database Design [2007]

(Sam Lightstone, Toby Teorey, Tom Nadeau) (Morgan Kaufmann - ISBN: 9780123693891)

**PNSQL:** Professional NoSQL [2011]

(Shashank Tiwari) (Wrox - ISBN: 9780470942246)

**RDDCE:** Relational Database Design and Implementation: Clearly Explained - 3<sup>rd</sup> Ed. [2009]

(Jan L. Harrington) (Morgan Kaufmann - ISBN: 9780123747303)

**SDBSW:** Seven Databases in Seven Weeks - 2<sup>nd</sup> Ed. [2018]

(Luc Perkins, Eric Redmond, Jim Wilson) (Pragmatic - ISBN: 9781680502534)

**SQLCE:** SQL Clearly Explained - 3<sup>rd</sup> Edition [2010]

(Jan L. Harrington) (Morgan Kaufmann - ISBN: 9780123756978)

**SQLRT:** SQL and Relational Theory - 2<sup>nd</sup> Edition [2012]

(C.J. Date) (O'Reilly Media - ISBN: 9781449316402)

**SQLVQS:** SQL Visual QuickStart Guide - 3<sup>rd</sup> Edition [2008]

(Chris Fehily) (Peachpit - ISBN: 9780321553577)