

## *ECE 356 Database Systems (Winter 2019)*

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This is an introductory course on database systems. It covers the basic concepts of data modeling and database-design methodology. The focus is on three main areas: (1) the principles of relational database management systems, the entity-relationship model, and the relational model, with focus on its mathematical foundation; (2) the methodology for building applications on top of database management systems and the data-modeling process; (3) the architecture of the modern database and the implications of that architecture for good database design.

Students will apply their learning through a series of labs that will demonstrate their ability to design relational schema using a modern RDBMS. All aspects of database design, from data modeling through to efficient implementation will be required in these labs.

### *Learning Outcomes:*

By the end of this course, students who have satisfactorily completed the course requirements should be able to:

1. Understand the Entity-Relationship Models (ERM) (entities, constraints, relationships, cardinality, primary and foreign keys)
2. Create an appropriate ERM given a broad set of requirements
3. Understand the Relational Model (RM: Relational Algebra (RA), 3-valued logic) and be able to transform an ERM to a RM
4. Recognize and create good relational designs for data, including functional dependency, normal forms, and relational decomposition
5. Recognize poor relational designs and explain why they are poor
6. Understand the basics of SQL, especially DML and DDL, but also DCL and TCL, and its integration into client application code
7. Transform a RM to SQL and RA to SQL
8. Understand the basics of transactions and the relationship between transactions and data integrity
9. Understand the basics of modern database architecture, including hashing and indexing, query optimization, data storage, concurrency control, transaction management, and failure recovery
10. Understand the significance of database architecture for good relational design and apply that to ensure good relational design
11. Understand the basics of database administration, setting up and managing a database, and security basics

*Prerequisites:*

Generically: level at least 3B Computer Engineering or Electrical Engineering. Specifically:

*Courses:* ECE 250, especially B-trees and Hash functions; ECE 103/108, especially set theory, relations, and proofs; ECE 254.

*Mathematics:* the ability to reason in propositional logic, as well as sets and relations, including the ability to do formal proofs.

*Language arts/English:* syntax, semantics, grammar, composition

*Practice:* recognizing that practice is essential to learning

A laptop: if you do not have one, contact the course staff immediately so that alternate arrangements can be made.

*Undergraduate Calendar Description*

“Data models, file systems, database system architectures, query languages, integrity and security, database design.”

*Course Website*

All information will be posted on Piazza and Learn. Learn will also be used for any quizzes we may have through the term. We will use the Piazza for surveys and as a discussion forum. The Piazza course website is:

<https://piazza.com/class/jqnxz0eifzr5g1>

The average response time for questions asked on Piazza is less than half-an-hour. Do not expect a rapid response to any other form of communication (e-mail, Learn posting, *etc.*). You should have been enrolled into this Piazza course already and received an e-mail requesting you sign up to Piazza. If you have not yet done so, do so now. If you have not yet received an e-mail regarding this, please notify the course staff so this can be resolved.

*Textbook*

Text: Silberschatz, Korth, and Sudarshan, *Database System Concepts*. McGraw-Hill. 6<sup>th</sup> edition. 2011.

Reference: C.J. Date and Hugh Darwen, *Databases, Types, and The Relational Model: The Third Manifesto*. Available at [https://www.dcs.warwick.ac.uk/~hugh/TTM/documents\\_and\\_books.html](https://www.dcs.warwick.ac.uk/~hugh/TTM/documents_and_books.html)

Slides will be posted on Learn and (at the instructor’s discretion) on Piazza. However, the slides will not, in general, contain sufficient

information to understand the course material. You will need to supplement it by some mixture of class attendance, problem solving, and reading the text and/or reference material.

### *Class Schedule*

#### *Lecture Schedule*

In the following table are the lecture topics by week and the objective(s) to which they contribute.

Week	Topic	Objective(s)
1	Introduction to database systems	3
1,2	Relational Model ; SQL DML and DDL language basics	3, 6
2,3	Relational algebra and relational calculus	3
3,4	Functional dependencies, relational decomposition, normal forms	3, 4, 5, 7
4,5	Storage and file structures	9, 10
5	Indexing and hashing	9, 10
7	Query processing and optimization	9, 10
7,8	Transactions	8, 10
8,9	Concurrency control	9, 10
9	Fault-tolerance and recovery	9, 10
10	Entity-relationship model	1, 2, 3
10	DB Admin and Security	11
11,12	Current topics (key-value stores, analytics, warehousing, ...)	

#### *Lab Assignments*

The course will have a series of lab exercises and coding requirements that collectively work towards, but are distinct from, the course project. These lab assignments will be focussed on SQL coding to solve specific, well-defined, problems. The lab component of the course is nominally worth 20%.

#### *Project*

The course will have a project, nominally worth 20% of your final grade. It can be done either individually or in groups of two. Specific details of the project requirements will be provided immediately post-midterm.

*Midterm Week*

Classes are not held during midterm week, which this term is February 25<sup>th</sup>–March 1<sup>st</sup>. The midterm exam for this course is from 8:00 AM – 9:45 AM on February 27<sup>th</sup> in E7-4043/4053/4417.

This date/time/location are tentative.

*Make-Up Lecture Dates and Tutorials*

Regular lecture times are Mondays and Fridays; so-called “makeup” lectures are approximately every other Tuesday, though There are no specific differencesno distinction will be made between between regular lectures and make-up lectures. Tutorials are either Monday or Tuesday at 4:30 PM, depending on which section you are registered in. While generally we will use the tutorial spots for tutorial-like material and the lectures for lecture-like material, either timeslot can be used for either type of material.

These lectures “make up” for the lost lectures during midterm week, when all lectures and tutorials are cancelled.

Tutorial-like material: problem solving  
Lecture-like material: new content

*Course Staff*

Instructor: Paul A.S. Ward  
Lab Instructors: Heshem Moussa  
Hossam Amer  
TAs: Anh Nguyen  
Han Weng  
Ricardo Manzano

Contact information is deliberately omitted. The preferred contact techniques are:

- Ask a question in class
- Ask a question on Piazza

For all course staff, office hours are by appointment. Please keep in mind that course staff have other responsibilities, so it may not be possible for them to meet with you at the last minute.

*Grading Scheme*

There are three evaluation components in the course with the following nominal weighting:

- Project: 20%
- Labs: 20%
- Exams: 60% (midterm 10%; final 50%)

### The “you gotta pass the exam to pass the course” Rule

If you do not do sufficiently well on the exam-component of the course, the nominal weightings are adjusted, as follows:

- Weight of exams:  $W_e$  (nominally 60%)
- Weight of labs and project:  $W_c$  (nominally 40%)
- Grade on final:  $F$

$$w_c = \begin{cases} 40 & \text{if } F \geq 55 \\ 2(F - 35) & \text{if } 40 \leq F < 55 \\ 10 & \text{if } F < 40 \end{cases}$$

$$W_e = 100 - W_c$$

### The “Letter Grades are Better!” Rule

Using the above weights, you have a computed grade,  $G$ , calculated as follows:

$$G = \frac{W_e}{100} \frac{5}{6} F + \frac{W_e}{100} \frac{1}{6} M + \frac{W_c}{100} \frac{C + P}{2}$$

where  $M$  is your midterm grade,  $C$  is your lab-coding grade, and  $P$  is your embedded-project grade, all out of 100.

Your nominal letter-grade value is then computed according to the standard conversion table. The initial submission of your final grade to the registrar’s office will then be the better of your computed grade,  $G$ , and the associated nominal value for the letter grade that corresponds to  $G$ .

*Note that this only applies to the initial grade submission to the registrar’s office. All adjustments and appeals will be based on your computed grade,  $G$ .*

Standard Letter-Percentage Conversion

Letter	Range	Nominal
A+	$90 \leq G \leq 100$	95
A	$85 \leq G < 90$	89
A-	$80 \leq G < 85$	83
B+	$77 \leq G < 80$	78
B	$73 \leq G < 76$	75
B-	$70 \leq G < 73$	72
C+	$67 \leq G < 70$	68
C	$60 \leq G < 67$	65
D	$50 \leq G < 60$	55
F	$0 \leq G < 50$	32

## Course Policies

### Late Submissions

Late lab and project submissions will not be accepted. The timestamp on Learn and or the auto-grader will be considered the official time of submission of any lab. Do not leave things to the last minute.

### Missing Something

If you miss the midterm exam and are able to provide a good reason, the grading scheme will change such that the final exam is (nominally) worth 60%. If you miss the midterm exam without a good reason, you will get 0 on the midterm and the grading scheme above still applies. The University rules say if you miss the final exam, without

Good reasons include: illness (submit a Verification of Illness (VoI) form), coop job interview (submit evidence of interview), etc.

an acceptable reason, your grade in the class will be “DNW - Did Not Write.” This is very undesirable. Show up for the final exam.

If you fail to submit your homework, lab submission, *etc.*, by the required deadline, any valid excuse must cover the entire period from the distribution of the item to the class up till the submission time for the total weight of the missing item to be shifted to the other homework assignments. If you have a valid excuse just for the day the homework is due, only an unscheduled justification (*e.g.*, illness) will be valid, and it will only be used to reduce a portion of the weight of the missing homework. Any scheduled activity on the submission day is presumed to be something that you should plan around, and will not be considered a valid excuse for failure to submit your homework.

### *Collaboration & Plagiarism*

Plagiarism, taking credit for work that others did, is not permitted, and this applies to source code as well as tests/exams. The course staff will be checking for it through a variety of different methods. Any cases of plagiarism detected will be reported, according to university policy (see the University Policy section below).

You may discuss ideas, algorithms, problems, possible solutions, *etc.*, and help other students debug small fragments of code. However, each student must submit his/her own, independently developed code for each lab and project. While it can be very useful to look at someone else's code you should not be doing that anywhere you might be writing your own code.

***Students are not permitted to share code, whether electronically or in written form.***

The University of Waterloo takes the issue of plagiarism very seriously (See UW Policy 71). If you are uncertain about this subject, please seek some guidance. There are many resources available to you. You can check the university policies, talk to your course instructor or support tutor, visit the First-Year Engineering Office, *etc.*

To sum this up in two short instructions:

1. Acknowledge the work of others.
2. If you are uncertain, ask!

### *Late Submissions*

Late assignments and project submissions will not be accepted.

### *Re-marking*

If you believe that your grade on an a written, submitted deliverable (*e.g.*, a midterm exam question) is incorrect or unfair, you may ask that

In the case of the group-project work, your group will submit its own independently developed code

You cannot become a great writer without reading the works of other great writers

God is watching and so are we: all code is subject to plagiarism analysis.

it be re-marked. Any request for remarking must be made within two weeks of the deliverable being returned to you. While you are free to identify the portion of the deliverable that you believe to be incorrectly graded, you should be aware that any regrading will be done on the entire submission. The reason for this is that while we acknowledge that mistakes can occur in which students are unfairly penalized, it is also the case that mistakes are made in which students receive higher grades for a question than is warranted. As such, and regrading may result in your grade going up, down, or remaining the same.

Please be aware that midterms are scanned before being handed back to students. As such if you attempt to add or change an answer you wrote on a midterm after it is handed back to you and then request a regrade, this is considered by the university to be cheating on an exam. This is very, very bad. Do not do this.

If the error you identify is simply one of an incorrect addition of the marks, then the correction will be made without requiring regrading.

We're not going to correct a mistake that cost you 3 marks on one question and ignore the fact that a grading error in your favour gave you 5 undeserved marks on a different question.

Yeah, about that: we don't actually tend to lower grades when you request a regrade, even if it is justified. I have to write this here, though, to reserve the right to do so in rare and exceptional circumstances.

### *Attendance & Illness*

It is usually a good idea to attend lectures. In particular, the average of the grades of students who attend lectures/labs/tutorials is about 20% higher than that of those who do not attend. That said, this is university and you are capable of deciding for yourself if you are going to the lecture or not. Attendance is not taken and not graded.

During the term, you may need arrive late to a class or leave partway through, because of co-op interviews. This is not a problem, as long as you are not disruptive when arriving/departing. Be mindful of your classmates.

Some submissions are required during labs, as identified above. In such instances you are required to attend.

If you feel ill, you should seek appropriate medical attention. If you miss an exam for health reasons, you need a Verification-of-Illness (VoI) form. Forms can be completed by the physicians at Health Services. Your completed verification of illness form should be presented to the First-Year Engineering Office and not directly to the course staff. If you anticipate missing a deliverable deadline or an examination for a non-medical reason, you should contact me as soon as you are aware of the problem. Given sufficient notice, alternate arrangements may be possible.

### *University Policies*

#### *Academic Integrity*

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty,

trust, fairness, respect and responsibility. For more information check:  
<https://uwaterloo.ca/academicintegrity/>

### *Grievance*

A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4:

[uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70)

If in doubt, contact the department's administrative assistant, who will provide further assistance.

### *Discipline*

A student is expected to know what constitutes academic integrity (see above section) to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71 (Student Discipline):

[adm.uwaterloo.ca/infosec/Policies/policy71.htm](https://adm.uwaterloo.ca/infosec/Policies/policy71.htm)

For typical penalties, check the Policy 71 appendix "Guidelines for the Assessment of Penalties":

[www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](https://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm)

### *Appeals*

A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed. A student who believes s/he has grounds for an appeal should refer to Policy 72 (Student Appeals):

[uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72](https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72)

### *Privacy*

Questions about the collection, use, and disclosure of personal information by the University, should be directed to the Freedom of Information and Privacy Coordinator, Secretariat, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada N2L 3G1. The email address of the Freedom of Information and Privacy Coordinator is [fippa@uwaterloo.ca](mailto:fippa@uwaterloo.ca). See also University of Waterloo Policy 46:



## Information Management

[uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-46-information-management](http://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-46-information-management)

### *Note for Students with Special Needs*

AccessAbility Services (AAS) located in Needles Hall, Room 1403, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Services office at the beginning of each academic term.