

Bilkent University

Department of Computer Engineering

CS281
Computers and Data Organization

Spring 2026

Dr. Mustafa Değerli

Final Examination

May 16, 2026

Duration: 133 Minutes

Number of Questions to be Answered: 5

Student Name and Last Name: _____

Student ID: _____

Student Signature: _____

Rules and Directions:

1. There are 6 questions on exam sheets. You may select up to 5 and attempt to answer them. If you answer more than 5 questions, only the first 5 (in numerical order) will be evaluated.
 2. You choose a question by writing your responses beneath the corresponding question.
 3. Each question is worth 20 points. Partial points may be awarded if any part of the answer is correct.
 4. The maximum time to complete the exam is 133 minutes, with no extensions under normal circumstances.
 5. During the exam, you may use printed copies of only the course slides and your own handwritten notes. No other printed materials are permitted.
 6. You are not permitted to use any electronic devices such as iPhones, smartphones, smart glasses, electronic rings, AirPods, tablets, iPads, smartwatches, laptops, or MacBooks. You must switch off all applicable devices and hand them over to the exam proctors.
 7. You are not allowed to ask questions or request clarifications during the exam. Answer based on your understanding of the questions as presented. If you make any assumptions, be sure to record them appropriately.
 8. Any attempt at cheating will result in your exam paper being marked, and you may receive a score of 0 for the exam.
 9. Remember, it is far more honorable to fail than to cheat.
 10. You may leave the exam room at any time, but once you exit, you cannot return.
 11. Be respectful of your fellow students by not causing any disturbances, allowing them to focus.
 12. Please write clearly and legibly. If your handwriting is difficult to read, you may lose points for the corresponding questions.
 13. Write your student ID and sign each page of the exam.
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I have read, understood, and concurred with all the rules and directions.

Student ID: _____

Sign: _____

Student ID: _____ Sign: _____

1. Assume the role of the CS281 professor and create a new question and answer pair that meets the following criteria:

- *Type*: Open-ended and reasoning-based (analytical, not just rote memorization).
- *Originality*: Substantially different from any previous quizzes, midterms, or current exam questions.
- *Topic*: Directly related to the discussions done in the class sessions.
- *Answer Length*: Strictly 10 to 13 sentences long.

(20 points)

Student ID: _____ Sign: _____

2. In the context of CS281, you have theoretically studied and practically appreciated both the gains and drawbacks of various conceptions. For each of the following, identify and explain their limitations or constraints in 2–3 sentences. (20 points)

a. Entity-Relationship (ER) Model

b. The Relational Model

c. Relational Calculus

d. SQL Query Language

e. Schema Refinement

Student ID: _____ Sign: _____

3. Please give answers to the succeeding sub-questions. *(20 points)*

- a.** Identify the normalization levels by name and state the condition(s) required to meet each level. *(10 points)*

- b. Assume you work for Tesla. A newly appointed manager, after casually coming across the concept of BCNF while scrolling through X during work hours, tasks you to redesign the following database schema to make it fully BCNF compliant. How would you respond? Explain your reaction and justify your decision with clear reasoning. (10 points)

Suppose Tesla keeps a table:

$R(\text{Customer}, \text{Vehicle}, \text{ServiceCenter})$

Denotation:

A customer owns a specific vehicle

Each vehicle is assigned to a specific Tesla service center

Each service center specializes in exactly one vehicle model/type

Functional Dependencies:

$(\text{Customer}, \text{Vehicle}) \rightarrow \text{ServiceCenter}$

A customer's vehicle is handled by a specific service center

$\text{ServiceCenter} \rightarrow \text{Vehicle}$

Each service center specializes in one vehicle type (e.g., Model Y only)

4. Kindly provide responses to the following sub-questions.

- a.** Define, discuss and exemplify the concept of *selectiveness* in database management system operations. (8 points)

An ideal answer shall include at least 7 well-developed sentences.

- b.** Provide a real-world example from your field of study where a hash-based dynamic index needs to be implemented and maintained. (6 points)

An ideal answer shall include at least 4 well-developed sentences. No credit will be given for examples pulled from the course materials.

- c.** Give a practical example from your field of study that requires the implementation and maintenance of a tree-based dynamic index. (6 points)

An ideal answer shall include at least 4 well-developed sentences. No credit will be given for examples pulled from the course materials.

5. Examine the following snapshots and rationalize their significance by relating them to the conceptions and discussions done in the class sessions.

a. (10 points)

An ideal answer shall include at least 10 well-developed sentences.

- ❖ Typical order: 100. Typical fill-factor: 67%.
 - average fanout = 133
- ❖ Typical capacities:
 - Height 4: $133^4 = 312,900,700$ records
 - Height 3: $133^3 = 2,352,637$ records
- ❖ Can often hold top levels in buffer pool:
 - Level 1 = 1 page = 8 Kbytes
 - Level 2 = 133 pages = 1 Mbyte
 - Level 3 = 17,689 pages = 133 MBytes

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b. (10 points)

An ideal answer shall include at least 10 well-developed sentences.

	(a) Scan	(b) Equality	(c) Range	(d) Insert	(e) Delete
(1) Heap	BD	0.5BD	BD	2D	Search +D
(2) Sorted	BD	$D \log_2 B$	$D \log_2 B + \# \text{ matches}$	Search + BD	Search +BD
(3) Clustered	1.5BD	$D \log_F 1.5B$	$D \log_F 1.5B + \# \text{ matches}$	Search + D	Search +D
(4) Unclustered Tree index	$BD(R+0.15)$	$D(1 + \log_F 0.15B)$	$D \log_F 0.15B + \# \text{ matches}$	$D(3 + \log_F 0.15B)$	Search + 2D
(5) Unclustered Hash index	$BD(R+0.125)$	2D	BD	4D	Search + 2D

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6. Explain the structural components of *the query optimizer* and *the index manager*, and connect these ideas to fundamental concepts in the industrial engineering context. In your elucidation, describe how each component operates, as well as how they interact with one another. A strong response shall provide a detailed discussion of their working principles, coordination, and relevance. (20 points)

An ideal answer shall include at least 13 well-developed sentences.

End of the CS281 Journey!

*Thanks a lot for your noble efforts.
You perfectly deserved it, and you should proudly celebrate...
Wishing you a bright, joyful, and successful future ahead!..*