#### DEPARTMENT OF COMPUTER SCIENCE

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Exam 25.09.2024

Databases I Summer Semester 2024

Name:

\_\_\_\_\_ Student ID: \_\_\_\_\_

Hints

- Check whether you received all pages of the exam (12 pages).
- Write your name or your student ID on each sheet of the exam and hand in all pages.
- All answers are expected to be written on the exam sheets.
- Clearly highlight and enumerate additional pages that are used for longer answers. Match your text with the according exercise.
- Only use pencils that are permanent and non-red colored.
- Use the notation and techniques discussed in the lecture.
- Exercises with more than one solution are not graded.
- You are allowed to use one A4 sheet with your personal notes (both sides, hand written or printed).
- Exam duration: 90 minutes

Signature

Grading

Filled by the examiner

Exercise	1	2	3	4	5	6	7	8	9	Sum
Total points	1	1	1	1	1	1	1	1	1	9
Points reached										

Exercise 1	1 Point

Mark the following statements as true  $(\mathbf{T})$  or false  $(\mathbf{F})$  with respect to the given ERdiagram. Incorrect answers will result in points being deducted!



- 1. There can be courses which are both a lecture and a proseminar.
- 2. There can exist a course which is neither a lecture nor a proseminar.
- 3. Each course has to be held by exactly one lecturer.
- 4. There can be lecturers who do not hold any courses.
- 5. A student can attend at most one course.
- 6. There can be courses which are not attended by any students.
- 7. A lecture may have multiple course numbers.
- 8. Different lecturers may have the same last name.

1 Point

#### Exercise 2

Draw an **ER-diagram** which satisfies the following requirements:

- 1. A trainer has a unique trainer ID, a name, and a gender.
- 2. A trainer can catch several Pokémon.
- 3. A Pokémon can only be caught by one trainer.
- 4. A Pokémon has a name, a type, and a level.
- 5. A trainer can additionally be either a gym leader or a professor.
- 6. A trainer can receive multiple badges from different gym leaders.
- 7. A gym leader awards badges to trainers.
- 8. A gym leader has a fixed location.
- 9. Professors research Pokémon.

Exercise 3	1 Point

Translate the following ER-diagram into a **relational schema** and state all **foreign key constraints** using projection and subset operations.



# Relational Schema (0.5 Punkte)

Foreign Key Constraints (0.5 Punkte)

Relational schema

 $Band(\underline{band}\underline{name}, founded)$ 

Released(album\_name, band\_name, label\_name, sales)

Label(label\_name, country, num\_employees)

Instrument(instr\_id, band\_name, description, value)

### Foreign keys

$$\begin{split} \pi_{band\_name}(\text{Released}) &\subseteq \pi_{band\_name}(Band) \\ \pi_{label\_name}(\text{Released}) &\subseteq \pi_{label\_name}(Label) \\ \pi_{band\_name}(Instrument) &\subseteq \pi_{band\_name}(Band) \end{split}$$

### Database instance for the following exercises

Band		Label		
band_name	founded	label_name	$\operatorname{country}$	num_employees
AC/DC	1973	Albert	Australia	15
Boston	1975	Asylum	$\mathbf{USA}$	75
Eagles	1971	Atlantic	$\mathbf{USA}$	130
Fleetwood Mac	1967	Apple	England	60
Guns N Roses	1985	Columbia	$\mathbf{USA}$	270
Led Zeppelin	1968	Geffen	$\mathbf{USA}$	100
Pink Floyd	1965	Harvest	England	40
The Beatles	1960	Warner Bros	. USA	650

#### Released

album_name	band_name	label_name	sales
Their Greatest Hits	Eagles	Asylum	29.000.000
Led Zeppelin IV	Led Zeppelin	Atlantic	23.000.000
The Wall	Pink Floyd	Harvest	23.000.000
Back in Black	AC/DC	Atlantic	22.000.000
Rumours	Fleetwood Mac	Warner Bros.	20.000.000
White Album	The Beatles	Apple	19.000.000
Appetite for Destruction	Guns N Roses	Geffen	18.000.000
Boston	Boston	Columbia	17.000.000
1967 - 1970	The Beatles	Apple	17.000.000

#### Instrument

$instr_id$	band_name	description	value
4	The Beatles	Rickenbacker 325	600000
17	The Beatles	Höfner $500/1$	350000
34	Guns N Roses	Gibson LP	490000
51	Led Zeppelin	Fender Telecaster	125000
74	Eagles	Takamine EF381	90000

The space above and below the message intentionally is left blank.

1 Point

Exercise 4

Formulate the following query using **relational algebra**. Pay attention to syntactic correctness.

1. List the founding date (founded) of all bands (band\_name) for which an instrument is registered. (0.4P)

List the names of all labels (label\_name) that have not yet released an album. (0.6P)

1 Point

Exercise 5

Formulate the following query using **SQL**. Pay attention to syntactic correctness.

Output the total value of all instruments per band. Bands without instruments should also be included (with a total value of 0).

Exercise 6 1 Point

Formulate the following query using **SQL**. Pay attention to syntactic correctness.

Output the country whose labels have sold the most albums. The result should include the country and the number of albums sold.

The exercise consists of 2 parts:

(Part 1) Create a temporary table using with that calculates the number of albums sold per country. (0.5P)

WITH country\_sales AS (

(Part 2) Now use the temporary table country\_sales from (Part 1) to formulate the original query. (0.5P)

Exercise 7

1 Point

Consider relation R[A, B, C, D, E] with the following functional dependencies:

$$F = \{ABD \to CE, \\ BCD \to E, \\ B \to ACDE, \\ A \to B, \\ CD \to AE\}$$

Find and list all candidate keys of R. Explain your answer.

Exercise 8	1 Point
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Consider relation R[A, B, C, D, E] with the following functional dependencies:

$$F = \{ACDE \rightarrow B, \\ D \rightarrow AC, \\ AB \rightarrow CE, \\ AD \rightarrow ABE\}$$

Compute the canonical cover  ${\cal F}_C$  of  ${\cal F}$  in the following four steps. Show your work for every step.

1. Left reduction.

# 2. Right reduction.

### 3. Remove empty sets.

4. Union.

Exercise 9

1 Point

Consider relation R[A, B, C, D] (already in first normal form – 1NF) with the following functional dependencies:

$$F = \{B \to D, \\ AD \to C, \\ AC \to D, \\ CD \to B\}$$

Compute the restrictions  $F_1$  and  $F_2$  of F to the decomposition  $R_1[BD]$  and  $R_2[ABC]$ . Either prove or disprove that this restriction is dependency preserving. Explain your answer.