Department of Computer Science

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PARIS LODRON UNIVERSITÄT SALZBURG

Databases I — Exam
Summer Semester 2026 — 15.09.2026

Last name: _____ **First 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.
- **Multiple-Choice**: Wrong answers result in point deductions!
- You are allowed to use one A4 sheet with your personal notes (both sides, hand written or printed).
- Exam duration: 90 minutes

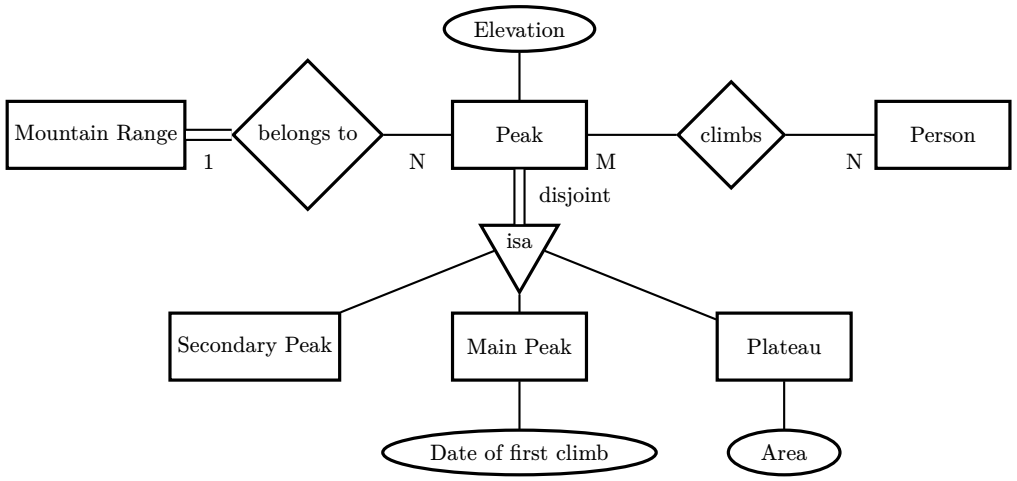
Signature _____

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 (**T**) or false (**F**) with respect to the given ER-diagram.



(1) There are mountain ranges without peaks. ☐

(2) Every person has to climb a peak. ☐

(3) Each peak is either a main peak, a secondary peak, or a plateau. ☐

(4) Every peak has a date of first climb. ☐

(5) Each secondary peak has an elevation. ☐

Exercise 2 — 1 Point

Draw an **ER-diagram** of a polyclinic database which satisfies the following requirements:

(1) Doctors treat patients at appointments. An appointment takes place at a specific point in time. An appointment is uniquely identified by the time and the patient. At a given appointment, a patient may be treated by several doctors.

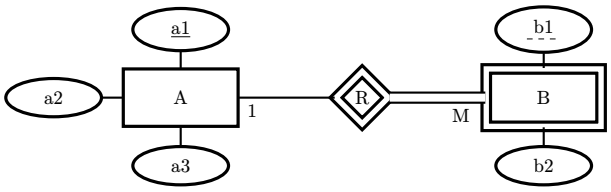
(2) A doctor has a unique name and a title. Each doctor must have at least one of the following specializations: general practitioner, dermatologist, orthopedist.

(3) A patient has a name and a unique social security number (SSN).

(4) At least one treatment must be performed at each appointment. The following treatments exist (with their respective attributes): prescription (possibly multiple medications), blood pressure measurement (blood pressure), and listening to the lungs (comment).

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 (0.6 Punkte)

Foreign Key Constraints (0.4 Punkte)

Schema for the following exercises

Relational schema

Listener(<u>user_name</u>, country, plan)

Album(<u>album_name</u>, artist_name, release_year)

Title(<u>album_name</u>, <u>title_name</u>, duration_sec)

Playlist(<u>playlist_id</u>, creator_name, playlist_name, visibility)

PlaylistTitle(<u>playlist_id</u>, <u>album_name</u>, <u>title_name</u>, position)

CountryStats(<u>album_name</u>, <u>title_name</u>, <u>country</u>, streams, skip_count)

Foreign key constraints

$\pi_{\text{creator_name}}(\text{Playlist}) \subseteq \pi_{\text{user_name}}(\text{Listener})$

$\pi_{\text{album_name}}(\text{Title}) \subseteq \pi_{\text{album_name}}(\text{Album})$

$\pi_{\text{playlist_id}}(\text{PlaylistTitle}) \subseteq \pi_{\text{playlist_id}}(\text{Playlist})$

$\pi_{\text{album_name,title_name}}(\text{PlaylistTitle}) \subseteq \pi_{\text{album_name,title_name}}(\text{Title})$

$\pi_{\text{album_name,title_name}}(\text{CountryStats}) \subseteq \pi_{\text{album_name,title_name}}(\text{Title})$

Instance for the following exercises

Listener (L)

user_name	country	plan
anna	AT	premium
bernd	DE	free
caesar	US	premium
david	DE	free
eva	SE	free

Album (A)

album_name	artist_name	release_year
Ambition	DiaoYeZong	2014
Turaida	Shikata Akiko	2013
Under the Crossroads	Yellow Squadron	2016

Title (T)

album_name	title_name	duration_sec
Ambition	Unprivileged Access	340
Ambition	Hokus Pokus	330
Ambition	Sundering of the Mortal Veil	340
Turaida	Buonanotte	210
Turaida	Ec Tisia	530
Turaida	Alvorna	300
Under the Crossroads	Into the Zuiun	220
Under the Crossroads	Blaze Heart	290

Playlist (P)

playlist_id	creator_name	playlist_name	visibility
1	anna	Road Mix	public
2	anna	Study Mode	private
3	bernd	Party Queue	public
4	caesar	Soft Hours	public
5	david	Local Picks	private

PlaylistTitle (PT)

playlist_id	album_name	title_name	position
1	Ambition	Unprivileged Access	1
1	Ambition	Hokus Pokus	2
1	Under the Crossroads	Into the Zuiun	3
2	Turaida	Ec Tisia	1
2	Turaida	Buonanotte	2
3	Ambition	Sundering of the Mortal Veil	1
3	Turaida	Alvorna	2
3	Under the Crossroads	Blaze Heart	3
4	Turaida	Buonanotte	1
4	Turaida	Ec Tisia	2
5	Under the Crossroads	Into the Zuiun	1

CountryStats (CS)

album_name	title_name	country	streams	skip_count
Ambition	Unprivileged Access	AT	6200	450
Ambition	Unprivileged Access	US	7600	NULL
Ambition	Hokus Pokus	AT	10200	810
Ambition	Hokus Pokus	DE	8900	NULL
Ambition	Sundering of the Mortal Veil	DE	4100	380
Turaida	Buonanotte	US	2300	95
Turaida	Ec Tisia	AT	1900	NULL
Turaida	Ec Tisia	JP	3300	210
Turaida	Alvorna	SE	3000	NULL
Under the Crossroads	Into the Zuiun	AT	5400	410
Under the Crossroads	Into the Zuiun	DE	5100	390

Exercise 4 — 1 Point

Formulate the following query using **relational algebra**, only use **basic/fundamental operators**: (**0.5P**)
Provide the title (`title_name`), album (`album_name`), and release year (`release_year`) of all tracks released in or after 2014 that are at most 300 seconds long (`duration_sec`).

Formulate the following query using **extended relational algebra**: (**0.5P**)
Provide the title (`title_name`) and album (`album_name`) of all tracks that appear in playlists created by users with a "premium" plan (`plan`).

Exercise 5 — 1 Point

Formulate the following queries using **SQL** for the schema on page 5.

1. Find artists (`artist_name`) with albums that have been streamed at least 10000 times in one country. (**0.5P**)

2. Find all playlists and their creators (`playlist_name`, `creator_name`) that are created by users with premium accounts and have a total duration of at least 20 minutes. (**0.5P**)

Exercise 6 — 1 Point

Formulate the following query using **SQL**. Always provide solutions that are generally valid.
During a data migration, NULL values were unintentionally introduced into the `skip_count` attribute of the `CountryStats` table and now need to be corrected. Provide the title (`title_name`) and album (`album_name`) of all tracks that have a NULL value for `skip_count` in at least one tuple and a non-NULL value for the same attribute in at least one other tuple. For each of these tracks, also provide the number of tuples with NULL values.

Exercise 7 — 1 Point

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

$$\begin{aligned} F = \{ & D \to CDE, \\ & E \to D, \\ & CEF \to EF, \\ & E \to ACDF, \\ & DF \to ACE\} \end{aligned}$$

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

Exercise 8 1 Point

Use the Armstrong axioms to show the soundness of the pseudo-transitivity rule:

$$X \to Y, WY \to Z \vDash WX \to Z$$

Exercise 9 — 1 Point

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

$$\begin{aligned} F = \{ & E \to C, \\ & BC \to E, \\ & ACDE \to B, \\ & E \to CD, \\ & A \to F \} \end{aligned}$$

Is relation R in 2NF? Explain your answer.

Which functional dependencies violate either 3NF or BCNF?

	Violates 3NF	Violates BCNF
$E \to C$	☐	☐
$BC \to E$	☐	☐
$ACDE \to B$	☐	☐
$E \to CD$	☐	☐
$A \to F$	☐	☐