ROYAL HOLLOWAY, UNIVERSITY OF LONDON
BSc/MSci EXAMINATION 2021

CS2855: DATABASES

CS2855R: DATABASES – for FIRST SIT/RESIT CANDIDATES

Time allowed: **TWO hours**

Please answer **ALL** questions.

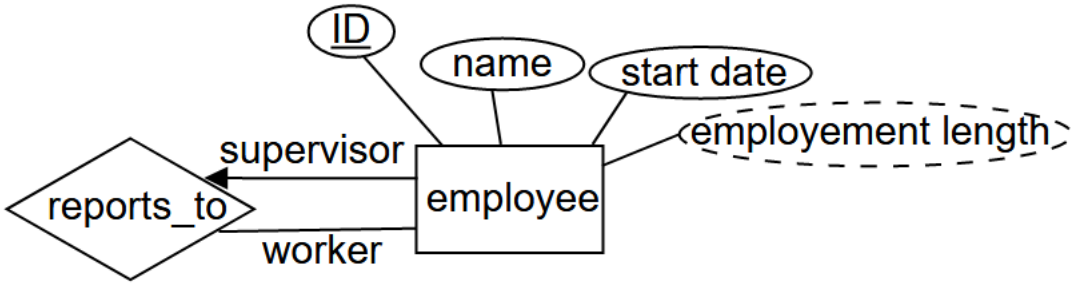
- Handwrite your answers on paper, and write your candidate number and the module number at the top of each page. Photograph/scan the pages and keep the original paper versions, as they may be required by the examiners.
- For each question you attempt, please clearly state the question number.
- Please DO NOT include your name or Student ID anywhere on your work.
- **Academic Misconduct:** We will check all assignments for academic misconduct. Suspected offences will be dealt with under the College's formal Academic Misconduct procedures. Please remember:
  - The work submitted is expected to be your own work and only your work. You may not ask for help from any source, or copy anyone else's work.
  - You must not give help to anyone else, including sending them any parts of the questions or copies of your solutions.
  - You must not discuss the questions or solutions with anyone else.
- **Submitting your work:**
  - Your document must be submitted through Moodle using the submission link in the module Moodle page. If possible please convert your document into a PDF document to make the submission process quicker and easier.
  - Emailed submissions will not be accepted.
  - **You must complete your exam upload within 1 hour of the exam finish time.**

1. RH-Solutions is a software company that specialises in fun games and server hosting. In what follows consider their database design.

   (a) The database for RH-Solutions keeps track of all the games produced by the company. Every game has an ID, a name, and a cost. A game is either released or it is under development. For every released game RH-Solutions stores in the database the release date and the number of sold copies. For every game that it is under development, the company stores the projected deadline. Draw an E-R diagram for this scenario (do not add information that is not present in the description). [10 marks]

   (b) In addition to the games, RH-Solutions offer several different types of servers to their customers. A server has an ID and a type. Every customer owns one or more servers of the company. Draw an E-R diagram for this scenario (do not add information that is not present in the description). [10 marks]

   (c) Transform the E-R diagram below to table schemas, that is, a sequence of attributes, specifying their primary keys, and below their foreign keys, if they exist. [10 marks]



2. Consider the following relational schemas (i.e., tables):

   - Project = (ProjectName, ProgrammerID)
     Foreign key: ProgrammerID referencing ProgrammerID in Programmer table.
   - Programmer = (ProgrammerID, ProgrammerName)
   - Task = (TaskID, ProjectID)
     Foreign Key: ProjectID referencing ProjectName in Project table.

   (a) Write the SQL definition of the relation Project (including integrity constraints); in other words, create a table in SQL. Use appropriate types for attributes. Assume that ProjectName is alphanumeric and ProgrammerID is an integer. [5 marks]

   (b) Assume that you want to add to the database a task with ID 23, for the new project named "Door" (this means that "Door" is not stored in the database). The programmer who is working on "Door" is named "Hodor" whose ID is 4312; Hodor's information is already stored in the database. Insert the data described above using SQL statements. [5 marks]

   (c) Write an SQL query that finds the number of programmers working on each project, sorted from high to low. [10 marks]

   (d) Write an SQL query that finds the project names that have at least three tasks associated with them. [10 marks]

   (e) Write an expression in Relational Algebra that lists all project names of those projects that only the programmer with ID=42 works on. [10 marks]

3. (a) Given below is the set F of functional dependencies for the relation schema $R = (A, B, C, D, E)$:

$$F = \{AB \rightarrow C,\ BD \rightarrow A,\ DC \rightarrow E\}\,.$$

i. Is there a redundant attribute in one of the functional dependencies in F, and if there is which is it? Explain your answer. [5 marks]

ii. Find a candidate key for R and explain your answer. [5 marks]

iii. Decompose the relation R into a collection of relations that are in **BCNF** (that is, in Boyce-Codd Normal Form). You have to show how you got your solution briefly. [10 marks]

(b) Given below is the set F of functional dependencies for the relation schema $R = (A, B, C, D, E, F)$:

$$F = \{A \rightarrow BC,\ BD \rightarrow E,\ E \rightarrow F,\ F \rightarrow D\}\,.$$

i. Provide all the candidate keys of R, and explain how you arrived at the answer. [5 marks]

ii. Is the following decomposition of R a lossless-join one? Explain your answer by showing the criterion for lossless-join decompositions and why the criterion is or is not met.

$$R_1 = (BDEF) \qquad R_2 = (ABCF).$$

[5 marks]

END